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SOME DIPTERA PUIPAPA FROM THE PHILIPPINE ISLANDS

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SEVEN TEXT FIGURES

Through the kindness of Prof. C. F. Baker a second small collection of Philippine Diptera Pupipara has become available and is here reported upon. It includes five species, of which four are from bats and were collected by Mr. Edward H. Taylor. Although these four bat-infesting species are described forms, I am here redescribing or figuring them, as the existing descriptions and figures are perhaps not readily accessible to eastern workers, and in some cases are not as satisfactory as might be desired.

A word as to the identification of species in this group may not be amiss. Almost all of the species are more or less soft-bodied, especially the female. Also, the abdomen of the female is subject to very striking, even though superficial, changes in appearance depending upon whether or not the insect is gravid. It consequently follows that care is necessary in interpreting the abdominal structures, for an insect that has but recently issued and is not full-fed may look at first glance very different from one of the same species that is full-fed or that has the abdomen distended by a fully formed larva. It is a most difficult, and in fact nearly impossible, feat to figure with any satisfactory degree of accuracy an individual in which the abdomen is shrunken and more or less telescoped. It may also be expected that forms in which the vestiture of setæ is

so extraordinarily developed will show a rather high degree of variability, and apparently some do. Just how much variation may be allowed before considering that specific limits have been overstepped remains to be determined, for in the case of most of the species long series have rarely been available. These facts should be clearly recognized by anyone who attempts to work in this group.

HIPPOBOSCIDÆ

Genus *ORNITHOPHILA* Rondani

But a single species of this genus has been known, although it was described as long ago as 1879, and this species was described from a single specimen. The description of the genus is clear enough, but that of the genotype, *O. vagans* Rondani, is so inadequate that its identity will probably long remain in doubt, unless the type is still in existence or specimens can be obtained from near the type locality.

It is consequently of considerable interest to find a species apparently referable to this genus occurring in the Philippines. There seems to be no question that this species is really referable to *Ornithophila* and, in view of the inadequacy of the description of *O. vagans* and the very great improbability that the Philippine species can be identical with the latter, which was described from Italy, I am describing it as new.

Ornithophila maquilingensis sp. nov. Figs. 1 and 2.

Material examined.—A single female, taken in flight in the forest on Mount Maquiling. This specimen is returned to Professor Baker.

Female.—General color a rather light brown. Length, 4 millimeters. Head (fig. 1) slightly broader than long; dorsal side destitute of setæ except three along the orbit, one being at the cephalic margin, one at the center, and one at the posterior margin, these long and slender, and a few very minute setæ between the cephalic and median long setæ; ventral side with numerous small, pale setæ; antennæ small and short; anterior margin of head produced past the apices of antennæ and with a deep median emargination; palpi and rostrum of nearly equal length, three-fifths as long as the head itself, the palpi with numerous small setæ; ocelli small but distinct.

Thorax with the humeral angles strongly produced into a broad, laterally rounded prominence bearing numerous small

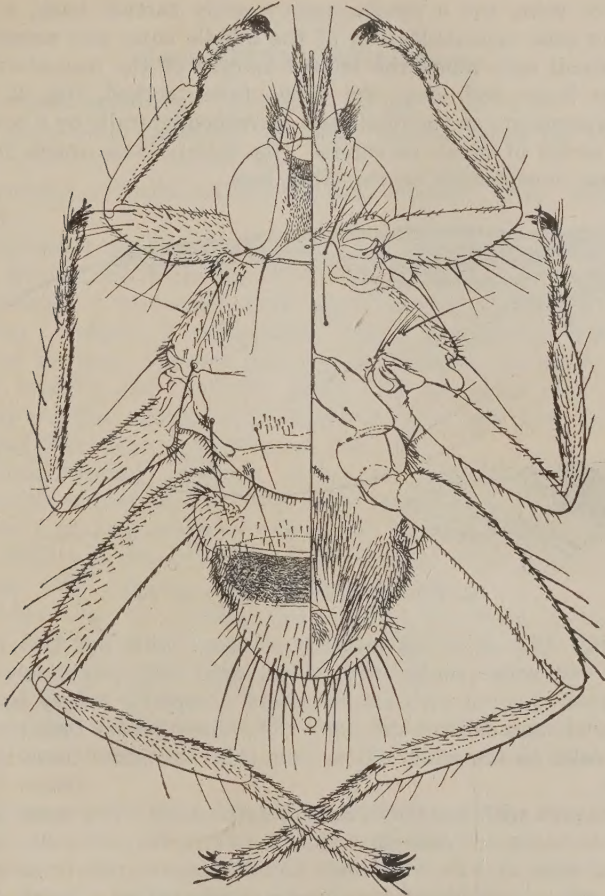


FIG. 1. *Ornithophila maquilensis* sp. nov.

setæ and one long seta; lateral margins of mesothorax with numerous small setæ and a single long seta just in front of the wing; mesonotum with a single prealar, one postalar, and one prescutellar and one scutellar seta on each side, these long and slender, and with numbers of very small setæ cephalad of the prealar and mesad of the prescutellar setæ; scutellum broadly rounded and fringed with a few minute setæ. Ventral side with the mesosternum slightly produced between the anterior coxæ; destitute of setæ except a pair of long ones between the

anterior coxæ and a similar pair slightly farther back, a row of long setæ cephalo-laterad of the middle coxæ and numerous very small setæ along the lateral margin of the mesosternum.

Legs large and long, the claws three-toothed (fig. 2, *b*); all the segments on the hind tarsi margined laterally by a continuous series of small serrations (fig. 2, *c*), these much fewer and less conspicuous on the other legs.

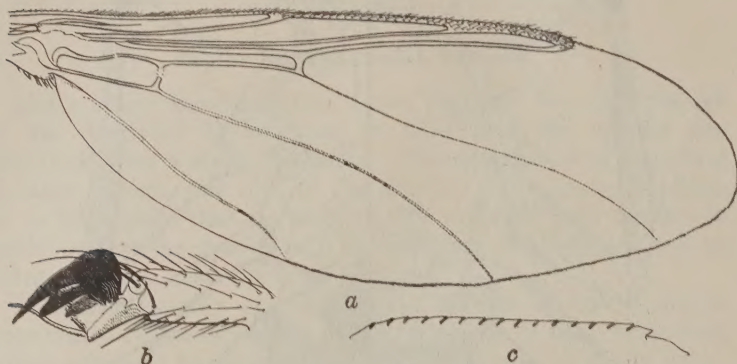


FIG. 2. *Ornithophila maquilingensis* sp. nov.

Wings (fig. 2, *a*), 5 millimeters long, with but two cross veins and consequently without an anal cell; completely and uniformly covered with minute setulæ except for a very narrow marginal area behind the anal vein, these setulæ imparting a gray color to the wing. It is impractical to show these in the figure.

Abdomen with a large basal tergite bearing a few small setæ; behind this is an area in which the derm is practically destitute of setæ and shows a very fine and close, transverse striation; posterior third of the dorsum composed of a single large plate bearing a number of large marginal setæ and a few small dorsal setæ. Ventral side membranous, with numerous setæ over the anterior half and several long setæ laterad of the genital opening.

Notes.—The single specimen available has the abdomen much shrunken and consequently it is impossible to determine the exact arrangement of the setæ on the ventral side. An expanded individual would probably look somewhat different but should be identifiable from the description and figures given.

STREBLIDÆ

Genus NYCTERIBOSCA Speiser

Nycteribosca amboinensis (Rondani). Figs. 3 and 4.

Nycteribosca amboinensis (Rondani) SPEISER, Archiv für Naturgeschichte 66: 1 (1900) 48.

Previous records.—Amboina and Burma, from unknown hosts.

Specimens examined.—A male and several females from a bat, *Miniopterus eschscholtzii*, Tablas Island (E. H. Taylor).

Female.—A moderately dark brown and extraordinarily hairy species. Length, 3 millimeters. Head concolorous with the rest of the body, the eyes scarcely recognizable, the entire head, both dorsally and ventrally, beset with numerous setæ; palpi broad and flat, fringed with long and short setæ and with numerous short setæ on the ventral side.

Thorax almost spherical, somewhat flattened dorsally and ventrally, almost concealed from the dorsal aspect by the great numbers of long, slender setæ which beset the entire dorsum and extend to the margin of the ventral side. Ventral side thickly and uniformly beset with small setæ.

Wings (fig. 4) slightly shorter than the body, beset with many slender setæ along the costal border and with areas of setulæ as indicated in the figure; veins weak, arranged as indicated in the figure.

Legs with the femora thickly beset above with long setæ except for a basal bare area; remainder of the legs thickly beset with small setæ.

Abdomen with the basal tergite divided into two broad lobes which have the apical third beset with many long setæ. Remainder of the dorsum thickly beset with slender setæ except for a broad, median area which is entirely bare. The setæ along each side of this area are especially long. Ventral side with an inconspicuous basal plate, this and the greater part of the remainder beset with small setæ. Apex of the abdomen terminating in a median lobe which bears numerous rather long setæ.

Male.—In its general characters like the female, but with the apex of the abdomen acutely pointed. Genitalia entirely internal, very small, apparently without the two flaps seen in the male of *Nycteribosca gigantea*. It is not possible to figure them from the specimen available.

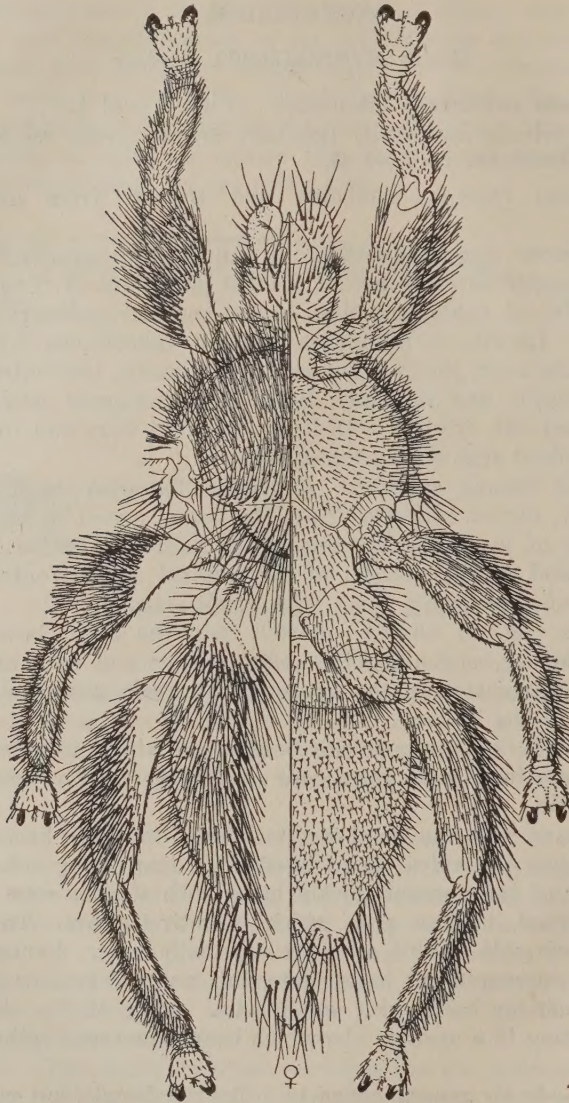
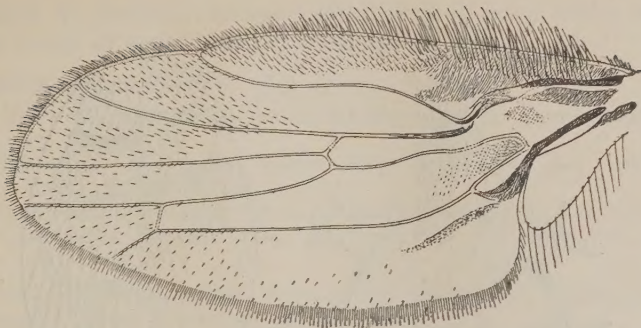


FIG. 3. *Nycteribosca amboinensis* (Rondani).

Notes.—The determination of this species is based entirely upon the key given by Speiser (reference cited) but seems to be reasonably certain. The species differs very markedly from *Nycteribosca gigantea*, which I have redescribed in an earlier

FIG. 4. *Nycteribosca amboinensis* (Rondani).

paper. Apparently it can be confused only with *N. kollari* (Frauenfeld) and the somewhat doubtfully distinct *N. diversa* (Frauenfeld) which occur in the Mediterranean region. According to Speiser it differs from these in its darker color and in the fact that the "fifth vein" ($M_3 + Cu_1$) attains the margin of the wing.

NYCTERIBIIDÆ

Genus NYCTERIBIA Latreille

Nycteribia allotopa Speiser. Fig. 5.

Nycteribia (*Listropodia*) *allotopa* SPEISER, Archiv für Naturgeschichte 67: 1 (1901) 47, tf. 1b.

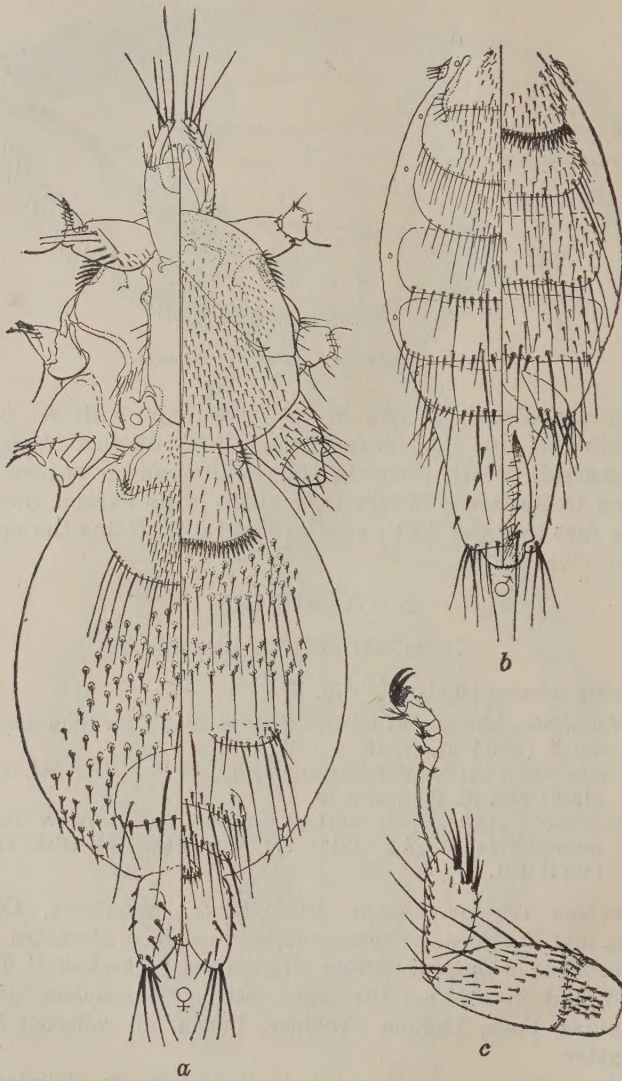
Nycteribia (*Listropodia*) *insolita* SCOTT, Trans. Ent. Soc. London (1908) 364, pl. 18, figs. 9-13.

Nycteribia (*Listropodia*) *allotopa* SPEISER, Scott, Archiv für Naturgeschichte 79 (A) (1913) 97; Ann. Mag. Nat. Hist. VIII 14 (1914) 221.

Previous records.—From *Miniopterus schreibersi*, Ceylon, China, and Formosa. From undetermined host, Sumatra.

Specimens examined.—From *Miniopterus eschscholtzii*, Tablas Island, and from either the same host or *Chaerophon luzonius*, Pagsanjan Falls, Laguna Province, Luzon, all collected by E. H. Taylor.

Notes.—This species appears to be extremely abundant on bats of the genus *Miniopterus* throughout the entire Orient. The various references cited contain adequate descriptions, but I am offering figures for convenience. The species seems to occur ordinarily in company with the next, *Nycteribia parvula* Speiser, and it is somewhat difficult to associate the sexes with each other.

FIG. 5. *Nycteribia allotopa* Speiser.

As far as I have been able to see, the males and females may be correlated chiefly by the form and extent of the abdominal ctenidium. In *N. allotopa* this ctenidium contains from 34 to 40 setæ and those on the meson are distinctly shorter than the others,

while in *N. parvula* it contains from 40 to 44 teeth, which are more nearly of equal length throughout.

Nycteribia parvula Speiser. Fig. 6.

Nycteribia (Listropodia) parvula SPEISER, Archiv für Naturgeschichte 67: 1 (1901) 48.

Nycteribia (Listropodia) sauteri SCOTT, Trans. Ent. Soc. London (1908) 366, pl. 18, figs. 14-18.

Nycteribia (Listropodia) parvula SPEISER, Scott, Archiv für Naturgeschichte 79 (A) (1914) 98; Ann. Mag. Nat. Hist. VIII 14 (1914) 222.

Previous records.—From *Miniopterus schreibersi*, Ceylon and Formosa. From undetermined host, Sumatra.

Specimens examined.—From *Miniopterus eschscholtzii*, Tablas Island, and from the same host or *Chaerophon luzonus*, Pagsanjan Falls, Laguna Province, Luzon, all collected by E. H. Taylor.

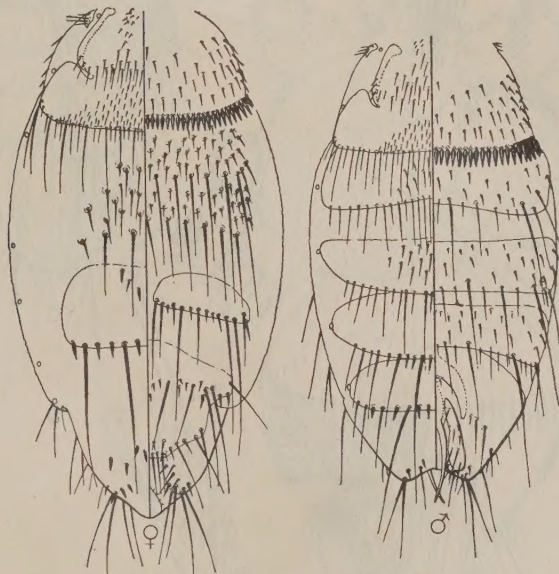


FIG. 6. *Nycteribia parvula* Speiser.

Notes.—This species, like the preceding, has been very adequately described, but I am presenting new figures. In the characters of the head and thorax it is practically identical with *Nycteribia allotopa*, so nearly so that I have not figured this portion of the body, but the abdomen is very different in both sexes and the legs are slenderer. The short terminal seg-

ment of the male and the very small, weak, and pale claspers are especially distinctive.

Genus *PENICILLIDIA* Kolenati

Penicillidia jenynsi (Westwood). Fig. 7.

Penicillidia jenynsi (Westwood) SPEISER, Archiv für Naturgeschichte 67: 1 (1901) 38.

Penicillidia jenynsi (Westwood) SCOTT, Trans. Ent. Soc. London (1908) 360, pl. 18, figs. 1-8; Archiv für Naturgeschichte 79 (A) (1914) 95; Ann. Mag. Nat. Hist. VIII 14 (1914) 213.

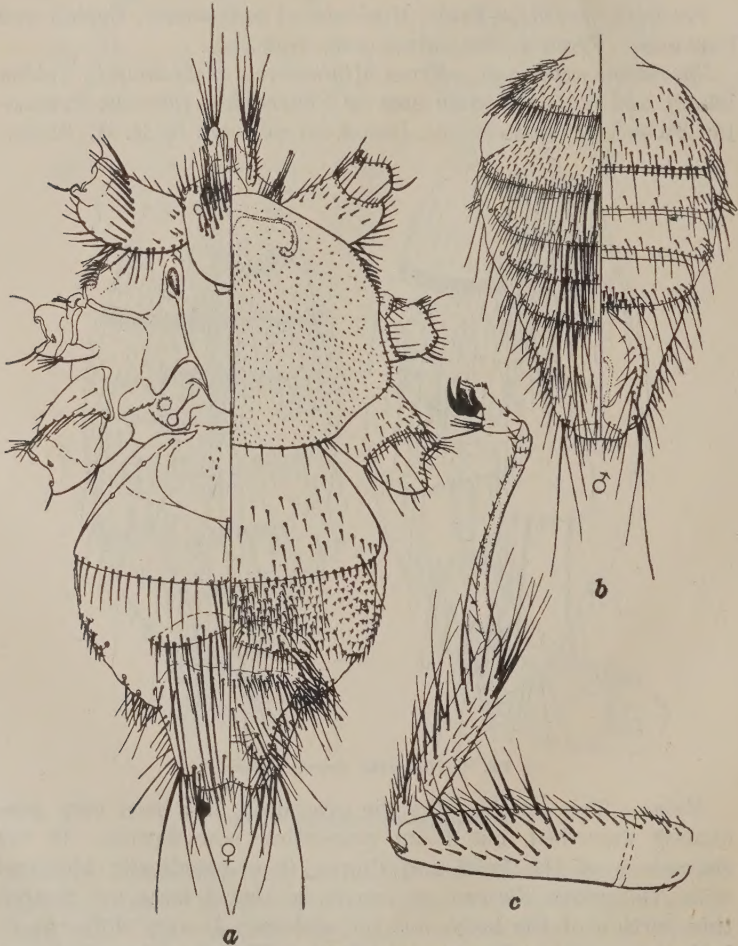


FIG. 7. *Penicillidia jenynsi* (Westwood).

Previous records.—From *Miniopterus schreibersi*, Ceylon. From China, Formosa, and Sumatra without indication of host.

Specimens examined.—From *Miniopterus eschscholtzii*, Tablas Island, and from the same host or *Chaerophon luzonus*, Pagsanjan Falls, Laguna Province, Luzon, all collected by E. H. Taylor. There are at hand also a single female from *Miniopterus tristis*, Lubang, Mindoro Province, and one from *Rhinolophus arcuatus*, Irisan, a barrio in Benguet Subprovince, both from alcoholic bats in the United States National Museum.

Notes.—The descriptions in the various references cited are sufficiently complete, but as in the case of the other species herein recorded I am presenting new figures. The species presents some variation, and in the specimen from *Miniopterus tristis* there is a conspicuous cluster of long setæ at the apex of the first abdominal tergite, but the essential specific characters remain constant.

ILLUSTRATIONS

TEXT FIGURES

- FIG. 1. *Ornithophila maquilingensis* sp. nov.; wings removed.
2. *Ornithophila maquilingensis* sp. nov.; *a*, wing (to same scale as fig. 1); *b*, claws of middle leg; *c*, serrations of lateral margin of segment 5, hind tarsus.
3. *Nycteribosca amboinensis* (Rondani); wings removed.
4. *Nycteribosca amboinensis* (Rondani); wing (to same scale as fig. 3).
5. *Nycteribia allotopa* Speiser; *a*, female; *b*, abdomen of male; *c*, anterior leg.
6. *Nycteribia parvula* Speiser; abdomen of male and of female.
7. *Penicillidia jenynsi* (Westwood); *a*, female; *b*, abdomen of male; *c*, anterior leg.



THE RECOVERY OF FUSEL OIL IN THE PHILIPPINES

By H. E. FOOTE

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THREE TEXT FIGURES

In investigating the possibilities of the profitable recovery of fusel oil in the distillation of alcohol, the Bureau of Science found that, up to June, 1923, no fusel oil had been recovered in the Philippines. Because the price of fusel oil in the United States was high and there were evidences of a rather serious shortage, it seemed a favorable time for the development of this branch of the alcohol industry in the Islands.

The following facts and results were obtained:

1. The average production of alcohol for the last five years in the Philippines has been 12,257,090 proof liters, or 3,242,616 proof gallons. Table 1 shows the yearly production for this period.

TABLE 1.—*Production of alcohol in the Philippines, 1919 to 1923.*^a

	1919	1920	1921	1922	1923
Proof liters ^b	14,972,293	11,716,896	9,232,900	11,584,129	13,892,231
Proof gallons ^b	3,960,924	3,099,064	2,442,566	3,051,356	3,658,592

^a Annual Reports of the Collector of Internal Revenue, Manila.

^b One U. S. gallon is equivalent to 3.78 liters.

Table 2 shows the percentages of alcohol produced from various sources in 1923.

TABLE 2.—*Sources of alcohol produced in the Philippines in 1923.*^a

Source.	Proof liters.	Per cent of total.
Nipa sap	3,809,108	27.30
Coco sap	654,903	4.70
Molasses	7,935,548	56.90
Cane sugar	1,539,054	11.00
Grain	83	
Other sources	3,075	.02
Total	13,941,771	99.92

^a Annual Report of the Collector of Internal Revenue, Manila, 1923.

2. The quantity of fusel oil occurring in the crude alcohol before rectification is about 0.4 per cent. Practically all of the fusel oil formed in fermentation is found in the crude alcohol; that is, little or none is lost in the distillation of the fermented molasses.

3. About 0.2 to 0.23 per cent of fusel oil is actually obtainable on a commercial scale from the crude alcohol.

4. About 65 per cent of the total alcohol output in the Philippines is produced in distilleries large enough to warrant the recovery of fusel oil. The remaining 35 per cent is produced in plants whose capacities are so small that fusel-oil recovery would hardly be profitable. Hence, it is estimated that the potential production of fusel oil in the Philippines, that is, the amount that could probably be recovered profitably, is about 3,500 gallons annually.

5. Assuming a price in the United States of 4 dollars per gallon for the crude grade and 4.75 dollars for the refined grade, and transportation charges of 1 dollar per gallon, the approximate value of fusel oil in Manila on the basis of present prices would be as shown in Table 3.

TABLE 3.—*Approximate value of fusel oil in Manila.*

	Dollars per gallon.	Pesos per liter.	Pesos per pound.
United States price:			
Crude	4.00	2.12	1.16
Refined	4.75	2.51	1.42
Transportation	1.00	0.53	0.29
Manila price:			
Crude	3.00	1.59	0.87
Refined	3.75	1.98	1.13

Hence, the value of the fusel oil available in the Islands would be approximately 10,000 to 13,000 dollars, or 20,000 to 26,000 pesos, annually. Japan is also a market for fusel oil, and it has the advantage that transportation costs from the Philippines to Japan are lower than those from the Philippines to the United States.

Table 4 shows price fluctuations of fusel oil since 1871.

6. The methods of recovery of fusel oil are not difficult, involving only processes familiar to the distiller, and require little additional equipment.

TABLE 4.—Price per gallon of fusel oil.^a

Year.	Refined.	Crude.
	Dollars.	Dollars.
1871.....	4.00	-----
1881.....	2.00	-----
1891.....	0.50	-----
1898.....	0.55 to 0.60	-----
1901.....	0.60 to 0.75	-----
1911.....	3.00 to 3.25	-----
1913.....	1.35 to 1.50	-----
1918.....	5.75 to 6.00	-----
1920.....	3.85 to 5.00	-----
1921.....	2.50 to 4.20	-----
1922.....	1.25 to 3.00	-----
1923.....	3.00 to 4.75	2.00 to 4.00
1924 ^b	4.75 to ^c	4.00 to 4.80

^a Oil, Paint, and Drug Reporter No. 14 101 (1922) 45 and 55, idem No. 14 103 (1923) 18 and 73; Drug and Chemical Markets 14 (1924) 288.

^b January only.

^c Nominal.

7. Although the quantities of fusel oil produced are small in relation to the quantities of alcohol, the costs of recovery are very low in comparison with its value.

8. One of the largest distilleries in the Islands, at Manila, is now successfully recovering all its fusel oil. Four others are making plans for its recovery as soon as possible. With the exception of one or two on the border line, these five distilleries constitute all of those in which the recovery of fusel oil would be clearly profitable.

Conclusion.—The work of the Bureau of Science has shown that fusel oil can be recovered profitably, and that small but paying quantities can be obtained at low cost and with little difficulty.

The fusel oil obtained from molasses consists mainly of two primary amyl alcohols, namely, the active $\text{CH}_3 \text{C}_2\text{H}_5 \text{CH} \text{CH}_2\text{OH}$ (boiling point 131.5) and the inactive or isoamyl alcohol $\text{CH}_3 \text{CH}_2 \text{CH}(\text{CH}_3) \text{CH}_2\text{OH}$ (boiling point 129), while the fusel oil obtained from nipa contains, in addition, considerable amounts of intermediate products, chiefly propyl and butyl alcohols. The molasses oil distills almost completely between 127° and 132° C., while the nipa oil distills between 115° and 135° C.

The chief uses of fusel oil are (a) as a solvent for nitrocellulose, (b) in the manufacture of special paints, varnishes, and lacquers, (c) in pharmaceutical work, and (d) in the manufacture of artificial perfumes and flavors.

Experiments were carried out to determine the quantities of fusel oil occurring in the manufacture of alcohol, the points in the process where it occurs in greatest quantity, and the best methods of concentration and purification. In most distilleries in the Philippines, the fermented material containing 5 to 8 per cent of alcohol is distilled in a continuous still which produces crude alcohol of 100 to 140 proof, or 50 to 70 per cent strength. This is then rectified in a discontinuous or batch rectifier, the contents of a large boiler being distilled through the usual column, dephlegmator, and condenser giving a distillate which is divided into several fractions as follows: (a) "heads" or aldehyde, (b) high-grade alcohol, the main product, (c) "tails," and, in the case of nipa alcohol, (d) "amilico" or fusel oil. The fourth fraction is sometimes obtained in the rectification of molasses alcohol and consists of a fusel oil-alcohol-water mixture containing as a whole 5 to 25 per cent of fusel oil. The percentage of fusel oil occasionally runs much higher (even as high as 80 per cent) for short periods of time during the distillation.

Experiment showed that practically all of the fusel oil formed in the fermentation is carried over into the crude alcohol in the first distillation. No fusel oil was found in the spent wash or "lees," and none was found in the heads, or aldehyde fraction (except for occasional traces due to small quantities of fusel oil being left on the plates of the column from the preceding run).

TABLE 5.—Values of coefficient k .

Alcohol, per cent by volume in boiling liquid.	k for fermentation amyl alcohol, boiling point 132° C.	k for ethyl alcohol, boiling point 78° C.	Alcohol, per cent by volume in boiling liquid.	k for fermentation amyl alcohol, boiling point 132° C.	k for ethyl alcohol, boiling point 78° C.
95.....	0.23	1.0037	50.....	1.20	1.50
90.....	0.30	1.02	45.....	1.50	1.63
85.....	0.32	1.05	40.....	1.92	1.80
80.....	0.34	1.08	35.....	2.45	2.02
75.....	0.44	1.12	30.....	3.00	2.40
70.....	0.54	1.17	25.....	5.55	2.70
65.....	0.65	1.23	20.....	-----	3.80
60.....	0.80	1.30	15.....	-----	4.10
55.....	0.98	1.39	10.....	-----	5.10

This may be explained by reference to Table 5 and to fig. 1.¹ The figures under k for ethyl alcohol represent the ratio of the percentage of alcohol in the vapor to the percentage in the boiling liquid for various mixtures of alcohol and water; those under k for amyl alcohol represent the ratio of the percentage of fusel oil in the vapor to the percentage in the boiling liquid for mixtures of alcohol and water containing small amounts of fusel oil. Notwithstanding the considerably higher boiling point of the fusel oil, it is seen that this ratio at low alcohol concentration is higher for fusel oil than for alcohol itself.

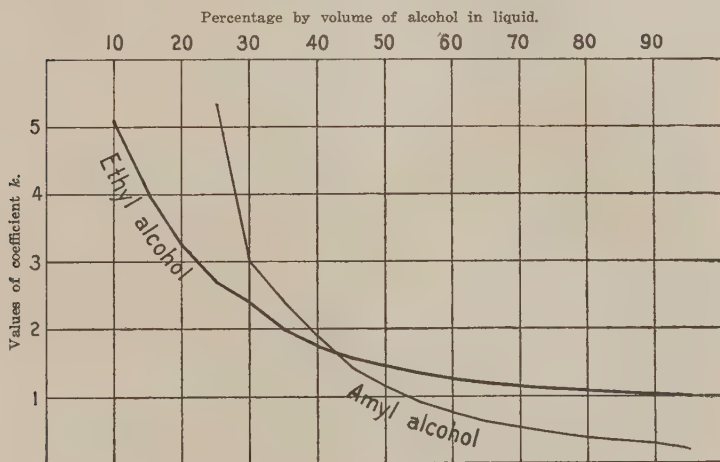


FIG. 1. Values of coefficient k for alcohol and secondary products.

Stated more simply, fusel oil is much more volatile with steam than with alcohol vapor. At concentrations of alcohol below about 43 per cent by volume—the point where the two curves cross—fusel oil is carried over completely; at 43 per cent the fusel oil-alcohol ratio is unchanged before and after distillation; and at higher concentrations of alcohol the fusel-oil content is reduced by fractionation. In the course of the experiments it was observed that at concentrations of alcohol in the distillate of about 90 per cent, or over, no fusel oil (less than 0.1 per cent) came over, whereas below this point as the grade fell off at the end of the rectification, fusel oil appeared in relatively large and increasing quantities (greater than 1 per cent).

¹ Monier-Williams, *Power Alcohol*. Frowde and Hodder & Stoughton, London (1921) 73, 74.

Therefore, the fusel oil is carried over into the distillate practically without loss in the distillation of the low-grade fermented material. In the rectification, however, where the alcohol concentration in the column remains high until the "tail" fraction of the run is reached and the alcohol is becoming exhausted, the fusel oil remains behind in the boiler and in the lower part of the column. As the alcohol disappears, the fusel oil, having become concentrated in the water remaining in the boiler, gradually rises in the column until it appears in the distillate, at first in the 90 per cent alcohol, gradually increasing in strength as the alcoholic grade falls. Finally, at a grade of about 40 per cent alcohol or less, the distillate comes over in two immiscible layers, the fusel oil floating on the weak alcohol. The proportion of top layer increases to a maximum, sometimes reaching 100 per cent if large quantities of fusel oil were originally present, and then falls off as the fusel oil is exhausted.

In a few factories in the Philippines, the rectification is carried out in continuous stills. In this case the crude alcohol enters the rectifier at a concentration of 30 to 35 per cent. The fusel oil tends to collect at a point in the column where the alcohol concentration is 43 per cent, as explained above, and is accordingly tapped off from the rectifying column as near this point of maximum concentration as possible.

The above general considerations will make clear the following methods developed for the recovery of fusel oil:

The process of obtaining the fusel oil, when batch rectification is used, consists in selecting that portion of the third and fourth fractions described above (the "tails" and "fusel oil") which is richest in fusel oil and collecting it in a separate tank. This material—in quantity about 1.5 per cent of the total crude alcohol—contains 15 to 20 per cent of fusel oil. The point at which fusel oil begins to appear in worth-while quantities is recognized partly by the hydrometer reading (92° to 93° Gay-Lussac, uncorrected, temperature about 30° C.) and partly by the characteristic residual odor when a sample is rubbed on the hands and allowed to evaporate. The maximum fusel-oil content occurs at a grade of 50° to 60° Gay-Lussac, and the fraction is collected until the grade has fallen to 20° to 30° Gay-Lussac, or until the top layer has practically disappeared.

The fusel-oil content of the distillate at any moment, when the rate of distillation is uniform, plotted against the grade shown by the hydrometer shows a gradual and regular rise and fall as in fig. 2; but, since the grade falls off very slowly at first, then

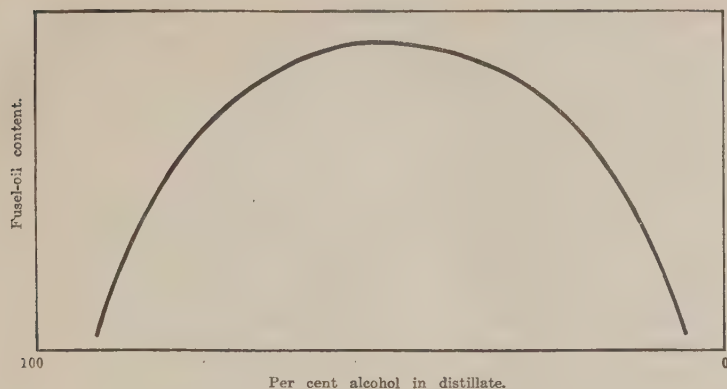


FIG. 2. Fusel-oil content against alcohol content.

with increasing rapidity down to the end, the fusel-oil content plotted against time shows a more gradual increase to a maximum and a rapid decrease at the end, as in fig. 3.

The 20 per cent fusel oil is stored until a sufficient quantity has accumulated and is then rectified in a small batch rectifier giving five fractions: (a) heads, (b) high-grade alcohol, (c) tails, (d) 20 per cent fusel oil as before, and (e) a fifth fraction in which fusel oil and water come over in two immiscible layers. The greater part of the fusel oil appears in the last fraction. The first fraction is small, the second rather large, the third and fourth are small, and the fifth is rather considerable in amount.

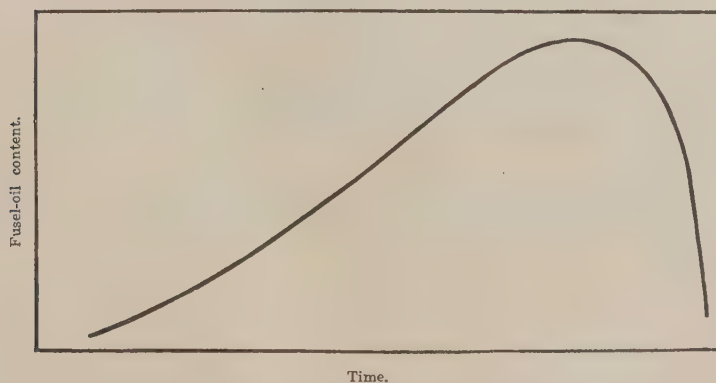


FIG. 3. Fusel-oil content against time.

The first four fractions are disposed of in the usual way exactly as in the large-scale rectification. The fifth is placed in a receiver by itself. The top layer is a fusel oil of from 70 to 90 per cent strength, and the bottom layer (about equal in quantity to the top layer) is water containing small amounts of alcohol and fusel oil.

If a crude fusel oil is desired as the finished product, the oil obtained as above is washed with water till it contains less than 10 per cent of alcohol. If a refined grade is required, the top layer, without washing, is rectified in the same rectifier and collected in three fractions: (1) alcohol containing fusel oil (this is placed in the 20 per cent fusel-oil receiver); (2) two-layer material consisting of (*a*) a top layer of crude 80 to 90 per cent fusel oil, about 70 per cent of the total, and (*b*) a bottom layer of water, about 30 per cent; and (3) refined fusel oil. The third fraction is usually 60 to 75 per cent of the total charge and boils, in the case of molasses alcohol, at 127° to 132° C. The distillation is carried as near to dryness as possible, using a gauge steam pressure of 50 to 150 pounds on the heating coil. In order to prevent excessive refluxing from the dephlegmator into the rectifying column, cooling water is not allowed to circulate after the two-layer fusel oil-water mixture is coming over; and when the dry fusel oil boiling above 127° is coming over, it is advisable to draw off the cooling water from the dephlegmator, leaving it dry.

If the rectification of alcohol in the plant is carried out continuously, the fusel oil will tend to collect on two or three plates where the alcohol concentration is approximately 43 per cent. The liquid on these plates is drawn off at such a rate and at such intervals that the fusel oil is prevented from accumulating on them in large quantities and is obtained at a maximum concentration. The fusel oil so obtained is partially freed from alcohol by washing and is further purified by rectification, as described.

Acknowledgement is made to Carlos Palanca and to Ayala & Co. for their kindness in furnishing facilities in their plants for the carrying out of this work.

ILLUSTRATIONS

TEXT FIGURES

- FIG. 1. Values of coefficient k for alcohol and secondary products.
2. Graph showing fusel-oil content against alcohol content.
3. Graph showing fusel-oil content against time.

POISONOUS AND WORTHLESS FISHES

AN ACCOUNT OF THE PHILIPPINE PLECTOGNATHS

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TWO COLORED PLATES

This order of fishes, the Plectognathi, includes the three suborders Sclerodermi, Gymnodontes, and Ostracodermi. Representatives of all of these suborders are common in the Philippines and, since many members of the order are to be looked upon with suspicion, if indeed their flesh is not actually poisonous, a knowledge of their characters becomes highly important.

Some of the members of this order are highly specialized and among the most singular of fishes, but the more generalized forms show plainly their descent from the order known as the Squamipinnes and especially from the Hepatidæ, of which they are a degenerate offshoot. Jordan states that there can be no doubt of a common and comparatively recent origin for the Balistidæ and the Hepatidæ.

The three divisions of this order are very easily recognized. The Sclerodermi have a spinous dorsal and a compressed, more or less distinctly scaled body, and the teeth are distinct and incisorlike. The Gymnodontes have no spinous dorsal, the teeth are fused into a beak with or without a median division in each jaw, and the skin is naked or covered with thorns, prickles, or hairlike bristles. In the Ostracodermi the spinous dorsal is wanting, the teeth are narrow and slender, and the body is inclosed by a rigid box of bone. This group includes the only members of the order with wholesome and palatable flesh. In at least two of the three suborders the flesh nearly always is not only thin, hard, often bitter, and usually unpalatable, but also contains poisonous alkaloids. These produce the disease known as ciguatera in which the nervous system is attacked and violent gastric disturbances, paralysis, and death may follow.

The order is well developed in the Tropics, but is rather feebly represented in cold waters, certain species being carried northward in warm ocean currents to the shores of Japan, Massachu-

setts, and England. Most of the species are comparatively inactive, poor swimmers, and rely upon their spines, bony plates, tough skin, or poisonous flesh for protection.

The Plectognathi are bony fishes in which the skin is usually covered with rough or spiny scales, or with bony modifications of the skin in the form of thorny spines or plates; sometimes the skin is entirely naked or with soft spines or bristles which simulate hair. The skeleton is imperfectly ossified, the number of vertebræ usually small, about fourteen to twenty, rarely much more numerous. In extremely specialized forms the vertebræ are so reduced that the tail fin seems attached to the head and the body is apparently wanting. The gill openings are small, narrow, restricted to the sides in front of the pectorals; the mouth is small, the bones of the upper jaw usually firmly united; the air bladder has no duct. The spinous dorsal is short, reduced to one prominent spine with one or two accessory ones, or else is lacking altogether; belonging to the caudal portion of the vertebral column is a soft dorsal, and opposite it or a little behind is the anal, the two fins usually much alike in shape and size; the ventral fin is reduced to a few spines or is absent, and the pelvic bones are usually elongate.

The sixty species treated in this paper probably represent nine-tenths of those actually dwelling in Philippine waters.

In this paper the length given for any fish does not include the caudal fin, unless it is so stated.

Suborder SCLERODERMI

This group is composed of plectognaths with a body approximating the shape of ordinary fishes, and with scales of regular shape but rough or bearing spines; the spinous dorsal is composed of one or more spines inserted just behind or above the cranium; the jaws have distinct conical or incisorlike teeth.

Key to the families of Sclerodermi.

- a*¹. Ventral fins each reduced to a large spine, normally articulating with the pelvic bones; scales rounded, more or less spiny, vertebræ nineteen.
Triacanthidæ.
- a*². Ventral fins wanting or reduced to a single spine at the end of the long pelvic bone; scales rough, rhombic, or spine bearing.
 - b*¹. First dorsal of three, rarely two spines, the first spine very large, the second locking it in erection; scales comparatively large, rough, bony, forming a coat of mail..... Balistidæ.
 - b*². First dorsal of one spine, with rudiment at its base; scales minute, not bony, the edges spinescent and the surface of the body rough velvety.

- c¹. Vertebrae eighteen to twenty-one; no barbel; gill openings beneath or behind the eyes..... Monacanthidae.
 c². Vertebrae twenty-nine or thirty; a long barbel on chin; gill openings before the eyes..... Psilocephalidae.

TRIACANTHIDÆ

HORNFISHES

Local name: *Sungay-sungayan*, Tagalog.

Body laterally compressed, with a similarly flattened, more or less elongate and attenuate snout, and covered with small or minute rounded scales which are more or less spine bearing. Mouth small, opening but slightly, with conical or incisorlike teeth in jaws, arranged in either one or two rows. First dorsal fin composed of three to six strong spines, the first much the largest; the soft dorsal rather long and low and similar to anal; both ventral fins reduced to a strong spine, nearly or quite as large as first dorsal spine and attached to the prominent pelvic bone; vertebrae $9 + 10 = 19$ in *Triacanthus*. The three large spines which give the family its name are locked in position when erect, thus making a formidable means of defense.

This family includes five genera, one Cuban, one Japanese, and three Indo-Australian, with but few species. They are all small and unimportant fishes, excessively abundant at times but rejected as food in most regions. However, the one peculiar to Japan is highly prized in the region about Nagasaki. In the members of this group the percentage of waste is so high that even if their flesh is not positively harmful it is so scanty and unpalatable that it is rejected. In the provinces I have seen fisherman throw away hundreds at a time, taken from their fish corrals. In Manila where the struggle for food is much more severe they are sometimes seen in the markets, mixed with other small fishes. Poor people sometimes seine them in considerable numbers in the bay along the sea wall beside Dewey Boulevard and prepare them in the following manner: The still flopping fish is grasped in both hands and given a quick hard transverse pull, which tears the fish in two directly behind the dorsal and ventral spines. The anterior half is thrown away and the skin is removed by a single jerk from the posterior half, thus yielding about two bites of meat.

I have found some of the characters, usually relied upon for distinguishing species, to be of little value. The presence or absence of a black or dusky spot on the distal portion of the first dorsal spine is not a valid specific character; neither is the

comparative length of the dorsal and ventral spines, since this varies greatly with age. Specific characters that seem to be trustworthy are the comparative size of the scales, the breadth of the muzzle and of the pelvic bone, the comparative lengths anterior and posterior to the ventral spines, and the shape of the snout.

One genus is found in the Philippines.

Genus *TRIACANTHUS* Cuvier

Triacanthus CUVIER, Règne Anim., ed. 1 (1817) 152, *biaculeatus*.

Body more or less elongate and compressed, covered with minute rough scales; tail slender and prolonged; teeth in two rows in each jaw, the outer one in upper jaw of eight or ten, that in lower jaw of ten incisors; teeth of inner row rounded, two to four in upper jaw, two in lower jaw. First dorsal with one very strong, rough spine, followed by four very much smaller ones; soft dorsal with from twenty-two to twenty-five rays, anal sixteen to twenty; lateral line sometimes conspicuous, especially posteriorly.

Species of this genus occur from the Persian Gulf to Japan and Australia.

Key to the species of *Triacanthus*.

- α^1 . First dorsal deep black with a dark blotch below; a black spot in axil of pectoral..... *T. brevirostris*.
- α^2 . First dorsal not deep black; no black spot in axil of pectoral.
- b^1 . Pelvic bone narrow; second dorsal spine not much longer than third; snout shorter, broader..... *T. blochii*.
- b^2 . Pelvic bone broad.
- c^1 . Second dorsal spine two or three times as long as third; snout elongate, narrow; caudal peduncle five times in length.
T. strigilifer.
- c^2 . Second dorsal spine short; caudal peduncle 6.3 to 7 times in length.
T. oxycephalus.

Triacanthus brevirostris Schlegel.

Triacanthus brevirostris SCHLEGEL, Fauna Japonica, Poiss. (1846) 294, pl. 129, fig. 2; BLEEKER, Atlas Ichth. 5 (1865) pl. 231, fig. 3; GÜNTHER, Cat. Fishes 8 (1870) 209; JORDAN and FOWLER, Proc. U. S. Nat. Mus. 25 (1902) 253.

Dorsal V, 23; anal 17. Head contained 3.7 times, depth 2.6 times in length; eyes contained 3.8 times in head and 2.5 times in snout, which is slightly concave, but little produced and 1.5 times in head and $2\frac{1}{2}$ times in depth; interorbital space broad, flat with a central ridge, 1.4 times the length of eye; first dorsal spine very stout, its length twice in head and 4.47 times in

head and body; ventral spines shorter and not quite so stout, 1.4 in head and a little over 5 times in length; anal contained 1.45 times in second dorsal, or 68.6 per cent, and 1.39 times in head; caudal peduncle contained 4.85 times in length; ten teeth in outer row in each jaw, the median pairs of comparatively large incisors, four rounded molarlike teeth in inner row above and two large rounded ones below.

Dark bluish gray above and whitish below a line extending from eye to middle of tail; whitish also around eyes and across occiput; interorbital space and snout dark; first dorsal fin deep black, with a dark blotch extending down on back below it; upper half of first dorsal spine white; a black spot in axil of pectorals and a dark blotch below them; a brilliant silvery luster over entire body; the remaining fins all pale.

Here described from a specimen collected at Amoy, China, by S. F. Light. It has a length of 170 millimeters, or 215 millimeters with the caudal fin.

There are several very small, immature specimens in the Bureau of Science collection, which were taken from Manila Bay.

Triacanthus blochii Bleeker.

Triacanthus blochii BLEEKER, Bijdr. Ichth. Singapore, Nat. Tijdschr. Ned. Ind. 3 (1852) 81; Atlas Ichth. 5 (1865) pl. 217, fig. 1; JORDAN and RICHARDSON, Bull. Bur. Fisheries 27 (1907) 272.

Dorsal V, 21; anal 17. Head contained 3.4 times, depth at posterior extremity of first dorsal (excluding the pelvic bone) 2.79 times, and depth at posterior extremity of the soft dorsal 8.27 in length; from tip of snout to ventral spine 28.8 per cent, and from latter to base of caudal 71.2 per cent of length; eyes moderately large, elongate, 3.18 times in head, 2.36 in snout, and 10.9 in length; snout rather short and full, a trifle less than $\frac{3}{4}$ as long as head, and 4.6 times in length; width of muzzle contained 4.37 times in head; first dorsal spine strong, rough, and very long, 3 times in length and $\frac{1}{2}$ longer than head; the remaining spines small, weak, and of approximately the same length except the last, which is very small; ventral spines resemble first dorsal spine but are shorter, being a trifle less than head and contained 3.6 times in length; anal short, its base about 1.6 in that of the soft dorsal; caudal peduncle relatively long and contained 3.3 times in length; eight incisors in outer row and four rounded teeth in inner row on upper jaw; ten teeth in outer row of lower jaw, the last pair much the small-

est, and two rounded teeth in inner row. Scales a little smaller than in *T. strigilifer*, but more spiny pointed and less rounded. Pelvic bone very narrow and sharp, its greatest width 17.5 times in length of head; its origin between the ventral spines.

Color in alcohol nearly uniform yellowish gray, with a dusky blotch on back around base of first dorsal, and short, indistinct dusky crossbands or blotches below the soft dorsal and top of caudal peduncle; underparts paler; upper part of first dorsal spine dusky or black, its lower part very pale or white; all fins pale or yellowish.

Here described from a specimen, 120 millimeters long, taken at Alaminos, Pangasinan, in Lingayen Gulf. Specimens of this and related species of approximately the same length show marked discrepancies when placed with their ventral spines together. In *strigilifer* the long concave snout and head extend much beyond those of *blochii*, while in the latter the trunk and tail extend much farther back than in *strigilifer*; the eyes and the pelvic bones also show marked differences.

The dorsal rays vary from twenty-one to twenty-three, the anal from sixteen to seventeen; the length of the first dorsal spine is subject to considerable variation, in young specimens being always much longer than the head, and in one it is 45.6 per cent of the entire length without the caudal fin; the eyes are proportionately larger also in the young, one-ninth or even one-eighth of the length.

I have examined seven specimens from Alaminos, Pangasinan, ranging from 59 to 123 millimeters in length; one from Calapan, Mindoro, 89 millimeters long; and four from Barotac Nuevo, Panay, from 47 to 81 millimeters long. On the last mentioned the dark bands are much more evident. In life the interspaces between the dark bands are evidently yellow spots or bands.

I also place here four small specimens from Manila Bay, varying from 61 to 82 millimeters in length, and two small, shriveled specimens, 64 and 75 millimeters long, respectively, collected by Alejo Arce at Calabanga, Camarines Sur Province. In all of them the snout and body above a line drawn from the eye to the middle of the caudal is nearly uniform brown, with the dark bands but little evident; all below this line is pale, yellowish to nearly white; the whole fish with a bright silvery luster.

This species is common throughout the Philippines and the East Indian Archipelago.

Triacanthus strigilifer Cantor.

Triacanthus strigilifer CANTOR, Cat. Malayan Fishes, Journ. Roy. Asiatic Soc. Bengal 18 (1849) 363, pl. 9; BLEEKER, Atlas Ichth. 5 (1865) 89, pl. 229, fig. 3; GÜNTHER, Cat. Fishes 8 (1870) 211; JORDAN and SEALE, Proc. U. S. Nat. Mus. 28 (1905) 790.

Dorsal V, 22; anal 17. Depth of body at posterior extremity of first dorsal, not including pelvic bone, 3.15 times in length; depth at posterior extremity of soft dorsal 10.9 in length; head contained 2.92 times in length; distance from tip of snout to ventral spine 37.09 per cent, from latter to base of caudal 62.91 per cent of length; eyes large, elongate, 2.3 in snout, 3+ in head, and 9.2 times in length; snout elongate, concave, with pinched, narrow, somewhat concave cheeks, 0.75 as long as head and 4 times in length; width of muzzle contained 8 times in head; first dorsal spine very strong, rough, and contained 3.75 times in length and 1.28 times in head; the remaining spines weak, the second spine twice or more than twice as long as the others; ventral spines similar to first dorsal spine but shorter, being contained 1.5 times in head; anal short, its base contained 1.6 times in that of second dorsal; caudal peduncle relatively short, being 0.2 of length; teeth of medium or small size, the median pairs much the largest, ten in outer row both above and below, the posterior pair in lower jaw very small; two rounded teeth in inner row in each jaw; scales in this species a little larger than in *T. blochii*. Pelvic bone broad and flat, its width one-tenth of length of head and nearly twice as wide as in *T. blochii*; it lies wholly posterior to the ventral spines.

Color in alcohol uniform yellowish brown, or brownish above and paler below, with a silvery luster over all; upper half of first dorsal spine dusky or blackish.

Here described from a specimen from Manila Bay, having a length of 120 millimeters. This species is easily recognized by its elongate, concave head and snout and meager body, and is distinguished from related species by the greater relative length before the ventral spines and the relatively shorter portion posterior to them.

The dorsal rays vary from twenty-two to twenty-three, the anal from sixteen to eighteen; the first dorsal spine varies

from 3.5 to 3.75 times in length; eye contained about 3 times in head. There are usually but eight teeth in the outer row of the upper jaw.

I have studied five specimens from Manila Bay, ranging from 93 to 120 millimeters in length without the caudal fin. This species occurs from the southern coast of China throughout the East Indies and is generally distributed in the Philippines.

***Triacanthus oxycephalus* Bleeker.**

Triacanthus oxycephalus BLEEKER, Verh. Bat. Gen. 24 (1852) 27, pl. 5, fig. 10; Atlas Ichth. 5 (1865) 90, pl. 220, fig. 3; PETERS, Monatsber. Akad. Wiss. Berlin (1868) 276; REGAN, Proc. Zool. Soc. London (1903) 183.

I have seen no specimens of this triacanthid, which was collected by Jagor at Catbalogan, Samar, as recorded by Peters. It can be readily distinguished from the others described in this paper by the greater number of dorsal rays and the much shorter caudal peduncle, as shown in the following description by Regan:

Depth of body $2\frac{1}{2}$ – $2\frac{1}{2}$ times in total length, length of head about 3 times, length of caudal peduncle $6\frac{1}{2}$ –7 times. Snout slightly concave, its length about $1\frac{1}{2}$ times in the length of head, eye-diameter 3–4 times, interorbital width $3\frac{1}{2}$ times. Interorbital space flat. Upper edge of occipital crest convex; distance from posterior margin of orbit to base of first dorsal spine about $1\frac{1}{2}$ times as long as the eye-diameter. D. V, 24–25; A. 17–19; first dorsal spine longer than the head, the others short; length of base of anal fin $1\frac{1}{2}$ – $1\frac{1}{2}$ times in that of the base of the soft dorsal fin; pelvis between the ventral spines broad anteriorly, tapering to a point posteriorly. Membrane of spinous dorsal fin immaculate. Total length 140 mm. Hab. East Indian Archipelago.

BALISTIDÆ

TRIGGER FISHES

Local names: *Papakol*, Tagalog; *pugot* or *puggot*, Visayan and Moro.

This family comprises a considerable number of tropical shore fishes, many of them of medium to rather large size, grouped in a half dozen genera and about fifty species. While some of them display very brilliant colors, as a group they are of singular, often bizarre or grotesque appearance, and lack the beauty and elegance of form and movement characteristic of many of the fishes of the coral reefs. They are carnivorous or partly herbivorous; some of the species feed upon mollusks and crustaceans and sometimes cause great damage to pearl-oyster beds,

their powerful teeth and jaws enabling them to crush the shells and thus get at the soft flesh within.

Although occasionally seen in the fish markets throughout the Orient, none of the Balistidæ are much used as human food. In some localities in the Philippines those of moderate size are eaten, but their sale here should be forbidden as their flesh is always more or less poisonous. In such places as Cuba and Mauritius they are not allowed in the markets as they are known to cause ciguatera.

Francis Day says: ¹

Dr. Meunier, at the Mauritius, considers that the poisonous flesh acts primarily on the nervous tissue of the stomach, occasioning violent spasms of that organ, and shortly afterwards of all the muscles of the body. The frame becomes racked with spasms, the tongue thickened, the eye fixed, the breathing laborious, and the patient expires in a paroxysm of extreme suffering. The first remedy to be given is a strong emetic, and subsequently oils and demulcents to allay irritability.

In his account of the backboned animals of Abyssinia, Rüppell states that *Balistes flavimarginatus* is very common in the Red Sea at Djetta,² where it is often brought to market, although only pilgrims, who do not know the quality of the flesh, will buy it. He goes on to say that as a whole the Balistidæ not only have a bad taste but also are unwholesome as food.

The oblong, ovate, or elliptical body is moderately compressed and is usually very deep anteriorly; it is covered with rather large rough scales, or scutes, of various shapes, which never form an immovable shell, or armor; the mouth is comparatively small, low, and terminal; the short jaws have a single row of separate, stout, coarse, incisorlike teeth; the eyes are very far back and high up, the preorbital being very deep and more or less bony; the small, slitlike, subvertical, or diagonal gill openings are above or in front of the pectorals, and are below or immediately behind a perpendicular from the eyes; the first dorsal is of only two or three spines, the first one is very robust and much the highest; when elevated it is locked in position by the second, which acts as a trigger; behind the first dorsal is a deep groove into which the dorsal spines are folded; it is formed by the fusion of most of the precaudal interneurals to form a bony trough attached to the skull; the second dorsal is usually far

¹ Fishes of India (1878) 686.

² "Djetta" I take to be the present City of Jedda, the well-known Arabian seaport, where vast numbers of Mohammedan pilgrims disembark every year on their way to Mecca.

from the first, of numerous soft rays, and opposite the very similar anal, both rather long as a rule; the caudal fin may be truncate, rounded, or deeply lunate, the shape often varying much with age in the same species; the ventral fins are absent, their place occupied by a single, stout, thick spine at the end of the very long and usually movable pubic bone; the precaudal vertebræ have well-developed parapophyses to which epipleurals are attached; the post temporal is short and simple, the forks obliterated, the bone grown solidly to the skull and without a foramen; ethmoid region long, without distinct nasal cavities; the palatine is movably articulated with the ectopterygoid or is entirely free from it; the premaxillaries are not protractile but are firmly united to the maxillaries; the lateral line is very faint or altogether absent. Vertebræ, $7 + 10 = 17$ or, according to Regan, 18.

Five genera and seventeen species are recorded from the Philippines; some of them are very abundant about the coral reefs. Several species of living Balistidæ are kept at the Bureau of Science Aquarium, where they are always of interest owing to their strange shape, coloration, and actions.

Key to the Philippine genera of Balistidæ.

- α^1 . Teeth white.
 - β^1 . Teeth uneven, oblique, more or less deeply notched.
 - γ^1 . Caudal peduncle flattened laterally.
 - δ^1 . A groove in front of eye..... **Balistes.**
 - δ^2 . No groove before eye..... **Balistapus.**
 - γ^2 . Caudal peduncle flattened dorsoventrally..... **Abalistes.**
 - β^2 . Teeth even, incisorlike..... **Melichthys.**
- α^2 . Teeth red or orange red..... **Odonus.**

Genus BALISTES (Artedi) Linnæus

Balistes LINNÆUS, after Artedi, Syst. Nat. ed. 10, 1 (1758) 327.

Parabalistes BLEEKER, Ned. Tijdschr. Dierk. 3 (1866) 10.

Pseudobalistes BLEEKER, Ned. Tijdschr. Dierk. 3 (1866) 11.

Sufflamen JORDAN, Copeia No. 29 (1916) 27.

This genus of highly specialized fishes has been divided by various authors into several subgenera and genera, and it is probable that differences in scalation, together with the form of the body and the fins, may be taken as generic characters.

Sufflamen may be a valid genus, but neither *Parabalistes* nor *Pseudobalistes* as defined by Bleeker is sufficiently well characterized to stand apart. In view of their intergradation and the unsatisfactory separation from *Balistes* of the three just named, the last named only is retained here.

The compressed body is covered with thick rough scales or plates of small or medium size, which do not overlap; there is a naked groove in front of the eye below the nostrils; the lateral line is very obscure and irregular, and is usually only visible when the scales are dry; the pelvic flap is large, more or less movable, and supported by a series of slender, sharp-pointed spines; the caudal peduncle is laterally compressed, its depth greater than its thickness, and the dorsal and ventral margins not flattened; it may or may not have scales with two to several rows of spines or tubercles and differentiated from the other scales of the body; the first dorsal is of three spines, the first of which is stout, rather blunt, with rough anterior surface, the other spines much smaller and the second acting as a trigger to lock the first when erected; the second dorsal and anal are long, similar to each other; the caudal fin is usually rounded, with the outer rays prolonged in the adults; the gill opening has several enlarged bony plates behind it; the cheeks are covered with scales, though in some species these may partially disappear in large old specimens or they may be in several widely spaced horizontal rows of small tubercles; the snout may be naked, partly covered with rudimentary scales, or entirely scaled: the teeth are irregular, notched, incisorlike, usually four on each side in each jaw; Günther was in error when he stated "Upper jaw with a double series of incisor-like teeth, eight in the outer and six in the inner series." Six of the teeth of the upper row have a long, broad grinding surface behind the outer chisel-like cusp, at least in some if not all of the species, but the whole forms a single tooth, as can be seen by extracting one.

The function of the armament of the tail is not certain; as it is little evident in the young, Günther believes that it may perhaps be a sexual character. While these fishes cause great damage to pearl-oyster beds, it is very probable that there would be few pearls without them. There is reason to believe that they are the host for the adult form of the larval nematode which creeps into the pearl oyster and causes it to secrete pearls.

Key to the Philippine species of Balistes.

- a¹. Head entirely scaled up to the lips. (Subgenus *Balistes*.)
 - b¹. Sides of tail without spines or tubercles..... *B. vidua*.
 - b². Sides of tail with several more or less complete rows of spines or tubercles. (Subgenus *Sufflamen*.)
 - c¹. Two or three rows of large white spots on lower half of body.
 - B. niger*.

- c². No rows of large white spots present.
- d¹. Pale bands around mouth and extending backward; no conspicuous dark bands on head or body.
- e¹. Caudal fin with conspicuous white crescent on posterior margin.
B. chrysopterus.
- e². Caudal fin uniform in color with body..... B. capistratus.
- d². No pale bands around mouth; conspicuous dark bands on head or body.
- f¹. Membrane of first dorsal with large dark spots; a dark band from above mouth backward toward pectorals; a broad blackish band across eyes to base of pectorals. B. viridescens.
- f². Membrane of first dorsal uniform in color, very dark.
- g¹. A dark crescent across hind margin of eye from below dorsal spine to base of pectoral; a similar band across base of pectoral behind gill slit, to below first dorsal.
B. bursa.
- g². Entire back dusky above a line from snout to upper base of caudal; a broad dark band from above pectoral downward and forward toward throat..... B. humilis.
- a². Snout more or less naked.
- h¹. Cheeks with horizontal naked stripes or grooves; scales on tail without spines. (Subgenus *Parabalistes*.)
- i¹. Cheek scales reduced to five or six widely spaced rows of small tubercles B. fuscus.
- i². Cheek scales separated by six or seven narrow stripes; body covered with irregular narrow dark longitudinal stripes..... B. rivulatus.
- h². Cheeks covered more or less completely with large scales; four to six rows of recurved spines on tail. (Subgenus *Pseudobalistes*.)
B. flavimarginatus.

Balistes vidua Solander.

Balistes vidua SOLANDER, MS. in Richardson, Zool. Voy. Sulphur, Ichthyology, Part 3 (1845) 128, pl. 59, figs. 9 and 10; GÜNTHER, Cat. Fishes 8 (1870) 216; JORDAN and EVERMANN, Fishes of Hawaiian Islands, Bull. U. S. Fish Comm. 23¹ (1903) 410, pl. 61.
Melichthys vidua BLEEKER, Atlas Ichth. 5 (1865) 109, pl. 217, fig. 2.

Dorsal III, 34; anal 30. Between seventy-five and eighty scales in lateral line and over seventy in a longitudinal series from gill slit to base of caudal rays; about forty scales between origin of first dorsal and anus; body moderately compressed, its greatest depth midway between first and second dorsals and equal to 0.5 length; the rather short deep head covered with scales to lips, and contained 3.58 times in length; the long, thick snout contained 4.5 times in length and is 81 per cent of length of head; mouth small, subterminal, lower jaw projecting; eyes small, circular, and placed well back, being about half a diameter in advance of first dorsal and contained 5.45 times in head; gill slit nearly vertical and below first dorsal spine, which

is rather stubby and a little more than half as long as head; behind gill slit and over pectoral lie six or seven enlarged bony plates, two of them much larger than the rest; no spines or tubercles on caudal peduncle; ventral spine short, stiff, and blunt; soft dorsal and anal rather high; caudal truncated or very slightly concave.

The above description is of a specimen obtained by me at Olongapo, Zambales, having a length of 218 millimeters, or 250 millimeters including the caudal fin. When fresh the whole fish was uniform brownish black except the posterior portion of the caudal peduncle, which was white; the caudal was pink with a white terminal stripe and a very thin black line along the dorsal and ventral edges; the first dorsal was olive brown; the second dorsal and anal were white, with a narrow black line along the whole margin; the pectorals were bright lemon yellow, the iris of the eyes also yellow; a faint pale line on the lips.

I have also examined a specimen, 204 millimeters long, from Monja Island, near Corregidor, collected by G. A. Lopez; and another, 186 millimeters in length, from Puerto Galera, Mindoro, collected by E. H. Taylor. In both there are about sixty-six scales in a longitudinal and about thirty-eight in a transverse series; none of my specimens therefore agrees with those of Günther, Jordan, and other authors who state that there are sixty scales in a longitudinal series, or with Günther's statement that there are thirty-two scales in a transverse series. In my specimens the head is 3.5 times or a little more or less in the length, while the snout is contained from 4.43 to 4.53 times.

The color in alcohol is very dark or blackish brown, the fins all fading out to white, except the marginal band of black on the soft dorsal and anal, and the first dorsal which remains dark brown; the caudal fin may be yellowish white.

My specimens agree in every essential with the published figures. This balistid, which has not been reported from the Philippines before, occurs throughout the southern Pacific Ocean in all the Polynesian islands, north to the Hawaiian Islands, and west to the Moluccas.

Balistes niger Bonaterre.

Balistes niger BONATERRE, Tabl. Encycl., Ichth. (1788) 19, pl. 85, fig. 152, after Sonnerat. Isle de France.

Balistes conspicillum BLOCH and SCHNEIDER, Syst. Ichth. (1801) 474; LESSON, Voy. Coquille, Zool. 2 (1830) 112, Atlas (1826) Poissons,

pl. 9, fig. 1; SCHLEGEL, Fauna Japonica (1846) 289, pl. 129, fig. 1; BLEEKER, Atlas Ichth. 5 (1865) 116, pl. 221, fig. 2; GÜNTHER, Cat. Fishes 8 (1870) 220; DAY, Fishes of India (1878) 689.
Pachynathus conspicillum JORDAN and FOWLER, Proc. U. S. Nat. Mus. 25 (1902) 256.

Dorsal III, 25-26; anal 22-23. Body subelliptical, its depth contained from 1.88 to 2 times, head from 3 to 3.25 times in length; snout but little curved, forming almost a straight line from above eyes to upper lip; about 0.8 as long as head and contained from 3.8 to 4.1 times in length; entire head covered with scales except the lips, which are broad and fleshy, equal or the lower one projecting; the sharp pointed teeth relatively smaller than in many other balistids; anterior end of gill slits below posterior margin of eyes or farther back; eyes of moderate size, 4.5 to 5 times in head, 3.5 to 3.9 times in snout; a patch of about five bony plates behind gill opening; about forty-five or forty-six scales from gill opening to last row of scales on caudal fin, and about thirty-eight scales from origin of the soft dorsal to anus; 2.5 to 3.5 rows of short spines on caudal peduncle; ventral spine broad, movable, and moderately long; the soft dorsal and anal rather low, caudal slightly rounded.

A specimen, 260 millimeters long to base of caudal, or 300 millimeters long over all, collected by me at Bungau, Sulu Province, had the following colors in life: Upper part of head and body black except from above eyes to second dorsal where it was greenish yellow, mottled with irregular lines and black dots; throat white with breast and body behind pectoral covered with large circular white spots, one row extending from pectoral to caudal and two irregular rows below; a broad greenish yellow band extended across forehead to below pupil of each eye; around mouth a broad yellow band, then one of black, then a narrow lavender pinkish line; the spinous dorsal black; the soft dorsal and anal with a bright yellow basal band, then pink, the marginal portion colorless; upper part of caudal peduncle lemon yellow; basal portion of caudal fin black, followed by a broad greenish yellow band, then a black band, with a narrow white edging.

Color in alcohol brownish black to black, with three or four longitudinal rows of very large circular white spots on lower half of body, the first beginning under pectoral fin; in front of pectorals and around throat the spots fuse to form a broad band; a paler portion extends from above eyes to second dorsal and down on sides to level of lower margin of eyes; it

is reddish brown or caused by a network of pale violet-tinged lines forming irregular polygons, each containing a dusky or brown spot on center of each scale, except near first dorsal where they cover more than one scale, the spots forming irregular longitudinal rows; a broadly V-shaped white band on forehead, extending back to below eyes; a bluish line around mouth followed by a broad white band, then a narrow black band, then a bluish or white stripe; a large white patch on caudal peduncle; first dorsal velvety black; soft dorsal and anal each with a white stripe along base, the rest of the fin bluish or pale; base of caudal with a broad blackish brown band, then a wide white band, followed by a narrower black band, with a white line forming posterior margin of fin.

I have examined two specimens, the one named above, and another collected at Cresta de Gallo, by G. A. Lopez. Although not previously reported from the Philippines, it undoubtedly occurs throughout the Archipelago, since it ranges from Madagascar to New Guinea, southeast to the Fiji Islands, and northward in the Kuro-Siwo to southern Japan.

Balistes chrysopterus Schneider.

Balistes chrysopterus BLOCH and SCHNEIDER, Syst. Ichth. (1801) 466; JORDAN and SEALE, Bull. Bur. Fisheries 25 (1905) 362; JORDAN and RICHARDSON, Bull. Bur. Fisheries 27 (1907) 272.

Balistes niger MUNGO PARK, Trans. Linn. Soc. 3 (1797) 37; GÜNTHER, Cat. Fishes 8 (1870) 218; DAY, Fishes of India (1878) 688, pl. 181, fig. 1; GÜNTHER, Fische der Südsee 3 (1910) 439; EVERMANN and SEALE, Bull. Bur. Fisheries 26 (1906) 99.

Balistes armatus LACÉPÈDE, Hist. Nat., Poiss. 1 (1798) 336, 382, pl. 18, fig. 2; BLEEKER, Atlas Ichth. 5 (1865) 115, pl. 216, fig. 1.

Balistes albicaudatus RÜPPEL, Neue Wirbelt., Fische (1835) 54, pl. 16, fig. 1.

Dorsal III, 27; anal 23. From forty-seven to fifty scales in a longitudinal series from gill slit to base of caudal and twenty-eight to thirty scales in a transverse series from anus to origin of first dorsal.

The compressed body shaped like an elongate pointed ellipse, its greatest depth more than half the length, and contained 1.9 times in length; the elongate head half or nearly half as long as trunk, its profile straight or slightly depressed just forward of eyes; the long thick snout from $\frac{6}{7}$ to $\frac{8}{9}$ as long as head; the rather large eyes placed high up and far back, their posterior margin above or slightly in advance of the lower anterior end of gill slits, and their longest diameter about 0.2

the length of head; behind gill slit half a dozen enlarged bony plates, one of them nearly as large as all the rest together; mouth terminal, small, with thick lips and equal jaws; first dorsal spine short, blunt, and a little more than half as long as head; ventral spine freely movable; seven or eight more or less complete rows of spines on caudal peduncle, their points strongly curved forward.

Color in life of a specimen 165 millimeters long, collected at Jamillo, Batangas, was dark brown, with breast and head from mouth to gill slits bright red; pectoral red; dorsal, anal, and caudal all had a marginal stripe of red, then a wide band of blue, the basal portion dark.

Color in alcohol is brown to blackish brown with breast and cheeks sometimes paler than rest of body; lips yellowish to whitish, with a bluish or dark band encircling them, this followed on lower lip by a white or pale stripe; on chin a white or pale band, which extends more or less backward upon cheeks; membrane of first dorsal chocolate brown, second dorsal and anal pale; the truncate caudal dark brown, with pale or white upper and lower margins and a distinct whitish or milk white half-moon on posterior margin.

This species is here described from the specimen already mentioned and three others, from the following localities: Iba, Zambales, length, 97 millimeters; Monja Island, 146 millimeters; Siasi, 77 millimeters.

The flesh of this little balistid, which is said not to exceed a length of 180 millimeters, is worthless. The fish occurs from the Red Sea, where it is common in the winter months, and Zanzibar, eastward throughout the Indian and Pacific Oceans as far as the Pelew and the Society Islands.

Balistes capistratus Shaw.

Balistes capistratus SHAW, General Zoölogy 5 (1804) 417; JORDAN and EVERMANN, Bull. U. S. Fish Comm. 23 (1903) (1905) 412, fig. 181; GÜNTHER, Fische der Südsee 3 (1910) 440.

Balistes frenatus BLEEKER, Atlas Ichth. 5 (1865) 114, pl. 223, fig. 2.

Balistes mitis GÜNTHER, Cat. Fishes 8 (1870) 218; DAY, Fishes of India (1878) 689, pl. 177, fig. 3.

Pachynathus capistratum JORDAN and FOWLER, Proc. U. S. Nat. Mus. 25 (1902) 255.

Dorsal III, 27; anal 24. Scales from gill slit to caudal rays, about fifty-two; depth of the rather elongate thick body contained about 2.2 times in length, head 3.2 times; snout nearly straight, its length 3.64 times in head and body, and $\frac{7}{8}$ as

long as head; eyes rather small and close to profile, 0.2 as long as snout and contained 5.7 times in head; head entirely covered with scales up to the thick fleshy equal lips; teeth very uneven; gill slits extend forward of a line from posterior margin of eye; five or six bony plates behind each gill slit, one of them much enlarged; about thirty-four scales in a transverse series from first dorsal to vent; ventral spine short and movable; posterior half of body and caudal peduncle with eight more or less complete rows of small tubercles bearing short sharp spines; soft dorsal and anal low, caudal nearly truncate, short, its length contained 9.5 times in length over all.

Color in alcohol uniform blackish brown, becoming much paler on belly, with concolorous caudal and vertical fins, except margins of soft dorsal and anal, which are pale; lips whitish yellow; a whitish stripe from each angle of mouth toward base of pectoral but stopping short of it; a similar stripe running around chin a short distance from lower lip and connecting the two lateral stripes.

Here described from a specimen 285 millimeters long over all, or 255 millimeters without the caudal fin; it was collected at Jamillo, Batangas; recently two more specimens, obtained at Zamboanga, were added to the Bureau of Science collection. This species has not been previously reported from the Philippines.

This balistid reaches a length of 400 millimeters and occurs from the east coast of Africa to the Hawaiian Islands and the islands of the South Pacific; only two examples have been recorded from Japan, and it is also rare in the South Seas, but is abundant in the East Indies.

Balistes viridescens Bloch and Schneider.

Balistes viridescens BLOCH and SCHNEIDER, Syst. Ichth. (1801) 477; BLEEKER, Atlas Ichth. 5 (1865) 112, pl. 231, fig. 2; GÜNTHER, Cat. Fishes 8 (1870) 220; Fische der Südsee 3 (1910) 441; DAY, Fishes of India (1878) 689, pl. 177, fig. 2; WEBER, Fische der Siboga Exp. 57 (1913) 574, pl. 10, fig. 15.

Dorsal III, 24, 25; anal 25. The broad compressed body twice or a little more than twice as long as deep; head contained from 2.8 to 3.1 times in length; the convex snout a trifle more than 0.75 as long as head and contained from 3.7 to 4 times in length; it is covered with scales up to the thick fleshy lips and has no naked places except the fold behind angle of mouth; upper lip projects beyond lower and does not entirely cover the

stout pointed teeth; eyes rather small, and contained from 5 to 6.75 times in head, or from 4 to 5.1 times in snout; several small bony plates behind gill slit, and from eighteen to twenty scales in a transverse row from dorsal fin to anus; twenty-nine or thirty scales in a row from gill opening to caudal fin; ventral spine short to very short and more or less movable; the bony ventral plates broad and thick; on caudal peduncle five or six rows of stout recurved spines; soft dorsal rather elevated, its height half the depth of body beneath, while anal is nearly as high; caudal truncate to rounded.

The color in one alcoholic specimen is uniform brown; in another the body is very dusky except on snout, chin, and breast, which are rosy to whitish; a broad indistinct blackish band across forehead and through eyes to pectorals; a broad blackish band above upper lip, above which is a narrow pale or white stripe; another broad dark band runs from above angle of mouth to a point below eye; a narrow white stripe below lower lip; soft dorsal, anal, and caudal each with a wide dark stripe near margin; first dorsal with large dark spots on membrane.

Here described from two specimens collected at Calapan, Mindoro, 400 and 299 millimeters long; a specimen 215 millimeters long, from Bantayan Island; and another specimen from Estancia, Panay, having a length of 255 millimeters. A specimen from Zamboanga is paler, with a dark spot on the center of each scale and with a wide dark blotch below the soft dorsal. In the University of Santo Tomas Museum is a specimen from Mindoro with a length of 305 millimeters, and one from Manila Bay with a length of 420 millimeters.

Previously recorded from the Philippines by Max Weber, who obtained a specimen 740 millimeters long at Sanguisiapo, Tawi-tawi. This is the largest species of *Balistes* and is said to reach a length of nearly a meter; those of small or moderate size are sometimes eaten. This fish is known to fishermen in most parts of the Philippines. It is found from the Red Sea and Zanzibar to New Guinea and Ponapé, one of the eastern Caroline Islands.

I also place here seven young specimens, 24 to 28 millimeters in length, collected by E. H. Taylor on the southern coast of Cotabato Province, Mindanao. Although not at all like the adult in color, they agree with Weber's figure of a young specimen. Our specimens have the sides of the body and the head sprinkled with conspicuous dark circular dots; the interorbital space is dark; there is a dark blotch on the membrane and around the

base of the first dorsal; there is a dark blotch under the first half of the soft dorsal and a dark band on the top and sides of the caudal peduncle.

Balistes bursa (Lacépède).

Balistes bourse LACÉPÈDE, Hist. Nat., Poiss. 1 (1798) 335, 375, pl. 7, fig. 1.

Balistes bursa BLOCH and SCHNEIDER, Syst. Ichth. (1801) 476; BLEEKER, Atlas Ichth. 5 (1865) 116, pl. 223, fig. 3; GÜNTHER, Cat. Fishes 8 (1870) 219; JORDAN and EVERMANN, Bull. U. S. Fish Comm. 23¹ (1903) 410, fig. 180.

Dorsal III, 28; anal 25-26. There are about fifty scales in a longitudinal series from gill slit to base of caudal and twenty-eight to thirty from first dorsal spine to anus.

The depth of the oblong, compressed body is nearly or quite one-half of its length; the deep, compressed, and pointed head contained a trifle more or less than 3 times in length; snout thick and forms $\frac{2}{3}$ or more of length of head; lips thick, jaws equal; eyes high up, very near profile, their diameter contained 4.25 to 4.3 times in head; posterior margin of eye above anterior or lower end of gill slit; length of first dorsal spine from 0.6 to 0.64 of length of head; ventral spine short, broad, and movable; three or four bony plates behind gill opening, one of them as large or nearly as large as all the others; a spinous tubercle on each scale on posterior part of body; these pass into short, stout, sharp-pointed spines below middle of soft dorsal, the spines appressed and pointed forward; tubercles and spines form elevated lines along each row of scales, which extend anteriorly in a reduced form to the region behind pectorals; lateral line more evident in this species than in most; beginning behind upper margin of eye it pursues an irregular course parallel with back as far as posterior part of first dorsal, then descends diagonally to middle of body where it disappears; in this portion there are from twenty-five to twenty-seven tubes. Proceeding forward, the lateral line passes below eye and divides, one branch extending on breast almost to median ventral line, the other curving downward and forward on snout to a point opposite angle of mouth; a branch passes from behind eye and over nape to the line on the other side.

Color in alcohol uniform olive brown, with light buff throat and breast; a dark brown crescent-shaped band passes from below first dorsal spine across posterior margin of eye to base of pectoral; another band of like color passes from below mid-

dle of first dorsal behind gill opening and across base of pectoral; a dark blotch extends from anus to and includes ventral spine.

The above description is based on two small specimens from Calapan, Mindoro, 135 and 101 millimeters in length. The fine yellowish or grayish white line which extends from the angle of the mouth to the anus has faded almost entirely. Another specimen, 110 millimeters long, from the same locality, is delicate pale brown anteriorly, becoming darker posteriorly, the throat and belly nearly white; the lips are yellowish white, surrounded by a bluish stripe; a bluish white line extends from the angle of the mouth nearly to the anus; the margin of the ventral flap is deep chocolate brown; the crescentic brown bands are as in the other specimens.

This species, which has not been hitherto recorded from the Philippines, is easily recognized by the crescentic dark brown bands between the first dorsal and the pectoral, and by the great development of spines on the posterior half of the body. This balistid occurs from the east coast of Africa, Madagascar, and the Red Sea, to the Hawaiian Islands, where it is common about the reefs.

Balistes humilis sp. nov.

Dorsal III, 25-27; anal 23-24. There are forty-five rows of scales from gill opening to caudal; about twenty-six in a transverse series from origin of soft dorsal to anal; depth $1\frac{7}{8}$ to 2, head 2.5 to 2.7 in length; snout 1.6 to 1.7 in head, eye 2.75 to 3 in head, 1.75 in snout; gill opening behind eye and just before or partly beneath first dorsal spine; four large bony plates behind gill opening; dorsal spine longer than snout and with two rows of upturned spinelets on its anterior surface; origin of anal posterior to that of dorsal, base of anal a little shorter than base of dorsal; scales on posterior half of body spinescent with small, slender spines, their tips usually hooked and pointing backward; ventral spine rather short, rough, movable.

Colors in alcohol are as follows: A dusky area from tip of snout back to top of caudal peduncle, including the spinous dorsal and extending in two places upon base of soft dorsal; small circular white spots often present in region just below dorsals; a broad dark band beginning above pectoral and passing diag-

nally downward and forward toward throat; lips whitish; sides and belly pale yellowish brown, more or less inclined to reddish.

Here described from thirty-two specimens, 25 to 32 millimeters in length, collected in March, 1923, on the southern coast of Cotabato Province, Mindanao, by E. H. Taylor. The type is No. 10252, Bureau of Science collection.

This immature fish does not agree with anything known to me, but is apparently nearest *B. niger*. Until additional material is available to show its adult form, its affinities cannot be stated with certainty.

Balistes fuscus Bloch and Schneider.

Balistes fuscus BLOCH and SCHNEIDER (1801) 471; GÜNTHER, Cat. Fishes Brit. Mus. 8 (1870) 222; SEALE, Occ. Papers Bishop Mus. 4 (1906) 73; GÜNTHER, Fische der Südsee 3 (1910) 442, pl. 168.

Balistes coerulescens RÜPPELL, Atlas Reise im Nördl. Afrika, Fische (1828) 32, pl. 7, fig. 2.

Balistes chrysospilos BLEEKER, Atlas Ichth. 5 (1865) 111, pl. 225, fig. 3.

Dorsal III, 26; anal 23; scales in longitudinal series fifty; scales in transverse series twenty-nine.

Depth of the oblong compressed body 1.7 in length; both upper and lower profiles convex, depth of head much greater than its length, which is 2.67 in head and body together; the boldly arched snout 3.5 in length and 1.3 in head; the elongate eye 4.6 in head and 3.5 times in snout, its posterior margin a half diameter before a perpendicular from first dorsal spine; the broad interorbital 3.3 in head; gill slit directly beneath first dorsal spine and longer than base of pectoral which lies immediately below and behind; least depth of caudal peduncle 3.6 in head; first dorsal spine stout, much shorter than anterior soft dorsal rays, its length twice the depth of caudal peduncle or 1.8 in head.

The broad lips thick and fleshy, the upper slightly projecting; behind them is a broad naked space which continues backward over most of the cheeks; this is crossed by five widely spaced and slightly convex rows of small tubercular scales; behind gill slit are three large bony plates; the long broad ventral spine movable; vertical fins rather high with strongly convex margin; anal slightly lunate; scales everywhere rough, but there are no spines or tubercles on those of tail.

Color in alcohol everywhere dark brown except on throat, which is paler; each scale on sides and breast with a large yellow spot, which becomes whitish in the preserving fluid; vertical fins each with many rows of similar spots and dark reticulations and a dark band near base, their margins whitish; caudal dark brown with a whitish posterior margin; pectoral dark brown with a broad whitish margin.

Here described from a fine specimen 235 millimeters long, or 284 millimeters including caudal fin, collected by E. H. Taylor at Tatayan Island on the southern coast of Cotabato Province, Mindanao. This species, which is new to the Philippines, is known from the Red Sea and Mauritius to the Fiji and Society Islands. In life it is said to be one of the most beautiful balistids, the ground color being deep blue with golden dots over the body and fins.

Balistes rivulatus Rüppell.

Balistes rivulatus RÜPPELL, Neue Wirbelt., Fische (1835) 56, pl. 16, fig. 2; GÜNTHER, Cat. Fishes 8 (1870) 222, after Rüppell.

Dorsal 26; anal 23. There are about forty-six tube-bearing scales in the very irregular lateral line and fifty-two scales in a longitudinal series from gill slit to base of caudal rays; there are about thirty-eight scales in a transverse series from the origin of soft dorsal to anus.

The depth of the compressed body at origin of first dorsal is 1.56 times, and from origin of second dorsal to anus 1.87 times in length; head large and deep, its length, measured from the lower anterior end of gill slit, contained 2.76 times in head and body together and 1.76 times in greatest depth; eyes high up, less than their own diameter from first dorsal, and 3 times in length of head and 2.8 times in the convex snout, which is contained 1.43 times in head and $3\frac{5}{8}$ times in length; there is a pronounced hump before eyes, and the wide, gently convex interorbital space is a little broader than an eye diameter and contained 2.6 times in head; snout partly naked anteriorly, with very small scales behind the bare portion; scales on cheeks separated by seven naked stripes; lips thick, tumid, corrugated, and equal; first dorsal spine rough, blunt, backward-curved, and short, its length 1.9 in head; gill slit slightly oblique, entirely posterior to eye, its lower end opposite upper end of base of pectoral, its length $\frac{5}{7}$ of eye, and with two enlarged

bony plates behind it; ventral spine rough and movable, and ventral flap margined by very slender sharp spines; soft dorsal and anal as high as dorsal spine, with rounded outlines, highest anteriorly; caudal peduncle narrow, its depth less than eye; caudal fin broad, with convex tip, its length a little more than height of dorsal spine; scales small, those on posterior half of body with a central rough tubercle; no spines on caudal peduncle; the well-developed lateral line begins behind upper half of eye, passes upward toward third dorsal spine, and then curves downward toward middle of anal, stopping at level of lower margins of caudal peduncle, then curving upward it passes along middle of caudal peduncle to base of caudal; one branch of the lateral line curves downward under eye and forward on cheek halfway between eye and mouth, then curving downward and forward it passes to angle of mouth; another branch leaves this just below eye and passes downward in front of pectoral, curving backward to a point below pectoral base, and then curves downward and forward, terminating low down on breast; another branch passes over in front of first dorsal and joins the lateral line on the other side.

Color in alcohol dull gray, everywhere marked with irregular, narrow, very dark bluish stripes, longitudinal on body, diagonal on sides of head, and broken on snout, throat, and breast; a broad bluish band between eyes; a small semicircular dark bluish spot below the spinous dorsal and a large dark bluish semicircular spot below anterior half of second dorsal; a dark bluish band encircles caudal peduncle; membrane of first dorsal black; soft dorsal has three, anal two parallel longitudinal bluish lines and rows of spots, and whitish margins; caudal bluish with crossbands and spots of blue; pectoral whitish. The ground color in life is said to be lemon yellow, with azure blue lines and stripes.

Here described from a specimen 58 millimeters long (70 millimeters long with the caudal fin), collected at Laiya, Batangas, in December, 1922. This handsome balistid was collected by Rüppell at Djetta, Arabia, on the Red Sea, nearly a hundred years ago. According to him, it reaches a length of "6½ inches," and was not particularly common. According to Günther, this is the young of *B. fuscus*. My specimen is exactly like Rüppell's excellent figure.

Balistes flavimarginatus Rüppell.

Balistes flavimarginatus RÜPPELL, Atlas Reise Nördl. Afrika, Fische des Rothen Meers (1828) 33; Neue Wirbelt. (1835-40) 54, pl. 15, figs. 1 and 2; BLEEKER, Atlas Ichth. 5 (1865) 113, pl. 218, fig. 3 (juv.); pl. 224, fig. 3 (aet. provect);^{*} GÜNTHER, Cat. Fishes 8 (1870) 223; Fische der Südsee 3 (1910) 443 (as *flavomarginatus*); DAY, Fishes of India (1878) 690, pl. 178, fig. 1; EVERMANN and SEALE, Bull. Bur. Fisheries 26 (1906) 99; JORDAN and RICHARDSON, Bull. Bur. Fisheries 27 (1907) 272. The correct form is *flavomarginatus*, but the original one, used by Rüppel, is followed.

Pseudobalistes flavimarginatus JORDAN and FOWLER, Proc. U. S. Nat. Mus. 25 (1902) 257.

Dorsal III, 26; anal 24-25. Scales in lateral line about thirty-five or thirty-six. The depth of the broad, thick body from 1.7 to 2.2 in length, young specimens deeper proportionately than larger ones; head contained from 3.1 to $3\frac{1}{2}$ times in length, its upper profile strongly convex; lips full, broad, fleshy, and in large specimens the upper one projects beyond the lower; teeth strong, the two median ones above large, conical, coarse, projecting; front of snout nearly naked, having but a few rudimentary scales; cheeks well covered with large scales in the young, but in old specimens they are only partly covered; snout contained from 3.6 to 3.9 in length and from 80 to 91 per cent of length of head; anterior or lower end of gill openings beneath eyes or just posterior to their hind margin, so that snout is nearly as long as head; eyes contained from 3.8 to 5.1 times in head and from 3 to 4.9 in snout; three or four bony plates behind each gill opening; from twenty to twenty-two scales in a transverse series from dorsal fin to anus; soft dorsal and anal fins rather high. The caudal varies much in shape with age; in the very young it is rounded and in those of moderate size it is truncate; in large old specimens the tail fin is deeply lunate with prolonged marginal lobes, and forms a fourth or more of the total length over all. Ventral spine short, movable, pelvic bone broad and prominent. There are five or six rows of small recurved spines on caudal peduncle in our specimens, their number and arrangement variable.

Color in alcohol nearly uniform brownish, snout, chin, and throat pale to yellowish or light buff, each scale with a large central dark spot; soft dorsal and anal with a yellowish margin and a broad dark band along middle; caudal with a narrow

^{*}The scales on the snout in the latter figure are not correctly drawn. The text reads *flavomarginatus*.

yellow margin followed alternately by a dark band, then another yellow stripe, and a second dark band.

In a large adult specimen the snout was more or less orange, the chin, throat, and breast nearly white, the rest of the body nearly uniform brown, without spots. Caudal, soft dorsal, and anal with yellow (white in alcohol) margin, followed by bands of dark brown, yellow (white), dark brown, and light brown; pectoral dark brown with a pale margin.

Here described from five alcoholic specimens ranging in length from 144 to 410 millimeters, from Calapan, Mindoro, and the reefs at the mouth of Manila Bay. I have also examined specimens from Cebu and Zamboanga. Our largest specimen, from Monja Island, has a length over all of 515 millimeters.

In the Bureau of Science Aquarium are a number of living specimens from Calapan, Mindoro. One of them is bluish gray, with a dark spot on each scale; the snout, chin, and breast are orange, as are also the cheeks except for a dark area below the eyes, which is of the general body color; the pectoral is orange, while the soft dorsal, anal, and caudal are orange with a rather wide bluish band near the outer margin; the one on the caudal is more or less crescent-shaped.

Some of these fishes are more or less olive green in life, while others are pale muddy yellow with the darker parts reddish brown.

This is a common species of the coral reefs; it reaches a length of more than 600 millimeters and is sometimes seen in the fish markets. Its flesh is not only of a very poor flavor but is also dangerous to eat. This species was originally described from the Red Sea; it ranges throughout the East Indies, northward to Japan, and southeastward at least as far as Samoa.

Genus **BALISTAPUS** Tilesius

Balistapus TILESIIUS, Mém. Acad. Sci. St. Pétersb. 7 (1820) 302.

This genus is separated from *Balistes*, to which it is closely related, by the absence of a groove in front of the eyes. The head and body are closely scaled, while the posterior parts are covered with more or less spinous scales. The lateral line is obsolete and there is a group of enlarged scales or bony plates behind the gill opening.

These small and brightly colored balistids are common in the tropical waters of the Indian and Pacific Oceans, to which they

seem to be confined. Four of the six or seven species known have been recorded from the Philippines.

Key to the Philippine species of Balistapus.

- α^1 . No black patch on caudal peduncle; sides dark with four pearly diagonal bands from middle of trunk to anal..... *B. aculeatus*.
- α^2 . A black patch or ring on caudal peduncle.
 - b^1 . Body covered with diagonal, often undulating, narrow stripes; patch on caudal peduncle circular..... *B. undulatus*.
 - b^2 . Body without numerous diagonal stripes.
 - c^1 . A black wedge-shaped patch on caudal peduncle, the point directed forward; a wide blackish band from eye and base of pectoral to vent and base of anal fin..... *B. rectangulus*.
 - c^2 . A dark band on caudal peduncle, bordered by broad pale bands; a very large blackish blotch from middle of body down to anal region *B. verrucosus*.

Balistapus aculeatus (Linnæus).

Balistes aculeatus LINNÆUS, Syst. Nat. ed. 10 (1758) 328; BENNETT in Beechey's Voy., Zool. (1839) 69, pl. 22, fig. 2; BLEEKER, Atlas Ichth. 5 (1865) 120, pl. 216, fig. 3; GÜNTHER, Cat. Fishes 8 (1870) 223; DAY, Fishes of India (1878) 690, pl. 178, fig. 3.

Balistapus aculeatus JORDAN and FOWLER, Proc. U. S. Nat. Mus. 25 (1902) (1903) 259; JORDAN and EVERMANN, Bull. U. S. Fish. Comm. 23 (1903) (1905) 414, pl. 62; EVERMANN and SEALE, Bull. Bur. Fisheries 26 (1906) 100; JORDAN and RICHARDSON, Bull. Bur. Fisheries 27 (1907) 272; WEBER, Fische der Siboga Exp. (1913) 576.

Balistes ornatissimus LESSON, Voy. Coquille, Zool. 2 (1830) 119; Atlas (1826) Poiss., pl. 10, fig. 1.

Dorsal III, 24-25; anal 21-22. There are forty scales in a longitudinal series from gill slit to base of caudal rays, and twenty-five (twenty-three to twenty-four, auctt.) in a transverse series from base of first dorsal spine to anus.

Body compressed, elongate-ellipsoid, its depth contained from 2 to nearly 2.5 times in length; the large, pointed head contained from 2.6 to 2.85 times in length; eyes placed very high up and almost at posterior extremity of head, in which they are contained from 5 to 5.6 times; the long thick snout just $\frac{1}{3}$ of length from its tip to base of caudal fin; lips thick and equal; from three to five enlarged bony plates behind gill slits, one of them nearly as large as all the rest together; length of the short, broad, blunt-tipped first dorsal spine less than half that of head; on caudal peduncle are two and a half rows of sharp recurved spines.

Color in alcohol varies from grayish to pale brown above; throat and belly pale to white; beginning behind gill opening and extending to caudal peduncle is a large ragged-edged dark

brown spot; from upper side of spot a band extends upward and backward to origin of soft dorsal, while from lower side five bands of greatly varying width extend diagonally backward, the first to anus, the next three to anal fin, and the last behind anal fin; between them are two pairs of bright pearl-white bands extending from middle of side diagonally to anal fin; a bluish band crosses over behind upper lip from one angle of mouth to the other; behind it is a yellow band which extends backward from angle of mouth to base of pectoral; a bluish patch between eyes is crossed by three narrower brown stripes; below eye three bluish stripes extend to base of pectoral; the blackish spines on caudal peduncle are upon a pearl-white patch; spinous dorsal brown, the other fins pale yellowish.

I have examined eleven alcoholic specimens, ranging in length from 35 to 151 millimeters, from the following localities: Puerto Galera and Calapan, Mindoro; Bacon, Sorsogon; Zamboanga; Samal Island; Guam. It has also been recorded from Cuyo by Jordan and Richardson and from Bacon and Zamboanga by Evermann and Seale; Weber collected it at Sanguisiapo. In the University of Santo Tomas Museum is a specimen labeled "N. de Luzon."

This handsomely colored fish, which well deserves Lesson's name "tres orné," is common about the coral reefs from the western part of the Indian Ocean eastward throughout Polynesia, including the Hawaiian Islands, and north to Marcus Island and the Riu Kiu Islands.

Balistapus undulatus (Park). Plate 1, fig. 1.

Balistes undulatus PARK, Trans. Linn. Soc. 3 (1797) 37; GÜNTHER, Cat. Fishes 8 (1870) 226; DAY, Fishes of India (1878) 691, pl. 177, fig. 4; WEBER, Fische der Siboga Exp. (1913) 575.

Balistapus undulatus JORDAN and SEALE, Bull. Bur. Fisheries 26 (1906) 35; EVERMANN and SEALE, Bull. Bur. Fisheries 26 (1906) 100; JORDAN and RICHARDSON, Bull. Bur. Fisheries 27 (1907) 273.

Balistes lamouroux QUOY and GAIMARD, Voy. Uranie, Zool. 2^e part. (1824) 208, pl. 47, fig. 1.

Balistes sesquilineatus BENNETT in Beechey's Voy., Zool. (1839) 69, pl. 21, fig. 3.

Balistes (*Balistapus*) *lineatus* BLEEKER, Atlas Ichth. 5 (1865) 118, pl. 229, fig. 2.

Balistapus lineatus FOWLER and BEAN, Proc. U. S. Nat. Mus. 62 (1922) 59.

Dorsal III, 24-26; anal 23-24. There are from thirty-seven to forty-two scales in a longitudinal series from gill slit to base of caudal rays and from twenty-six to thirty in a series between base of first dorsal spine and anus.

Depth contained from 1.9 to 2.2 times in length; head very deep, its length 3 to 3.2 times in length; eyes high up and far back, being very close to posterior extremity of head, in which they are contained 4.8 to 5 times; the thick, slightly concave snout 4 times or a little more than 4 times as long as eye diameter; lips fleshy and jaws equal; behind each gill slit is a patch of from four to six enlarged bony plates; on caudal peduncle are six or eight stout to very long and strong spines in two rows.

The color in alcohol varies from light brown to nearly black, with yellow or pale fins, except the spinous dorsal which is dusky, with a broad black margin on anterior part. Head and body covered with diagonal stripes, usually pale, yellow, orange, or whitish, which pass from dorsal surface to anal and caudal; several also pass from about mouth and chin and unite posteriorly to form a broader stripe which extends back to below pectoral; under chin is a black stripe which stops below pectoral; there is a circular black patch on caudal peduncle in which are the caudal spines; there is a narrow dark band along base of second dorsal and anal fins.

I have examined thirteen alcoholic specimens, varying in length from 65 to 170 millimeters, collected in the following localities: Iba, Zambales; Calapan and Puerto Galera, Mindoro; Cabalian, Leyte; Puerto Princesa, Palawan; Balabac; Samal Island, Mindanao; and Sitanki.

This species has been previously recorded from Cavite by Jordan and Seale; from Cagayancillo by Jordan and Richardson; from Bacon, Sorsogon, by Evermann and Seale; from Sanguisiapo in the Tawitawi group by Weber; and from Zamboanga by Fowler and Bean.

This balistid, which reaches a length of more than 300 millimeters, is very abundant about coral reefs in the Indian and Pacific Oceans, and ranges from the Red Sea and Mozambique east and north to the coast of China, the Riu Kiu Islands (?), Guam, and the Society Islands.

***Balistapus rectangulus* (Bloch and Schneider).**

Balistes rectangulus BLOCH and SCHNEIDER, Syst. Ichth. (1801) 465; GÜNTHER, Cat. Fishes 8 (1870) 225; DAY, Fishes of India (1878) 691, pl. 178, fig. 2.

Balistapus rectangulus FOWLER, Proc. Phil. Acad. Nat. Sci. (1900) 514; JORDAN and EVERMANN, Bull. U. S. Fish Comm. 23 (1903) 413, pl. 63; JORDAN and RICHARDSON, Bull. Bur. Fisheries 27 (1907) 273.

Balistes medinilla QUOY and GAIMARD, Voy. Uranie, Zool., 2° part. (1824) 206, pl. 46, fig. 2.

Balistes erythropteron LESSON, Voy. Coquille, Zool. 2 (1830) 123, Atlas (1826) Poiss. No. 210, fig. 3.

Balistes cinctus BLEEKER, Atlas Ichth. 5 (1865) 119, pl. 228, fig. 1.

Dorsal III, 24; anal 21. There are about forty scales in a longitudinal series from gill slit to base of caudal fin and about thirty in a transverse series from first dorsal spine to anus.

Depth a trifle more than half of length, and head contained 2.58 times in length; snout contained 1.4 times in head and is 2.2 times as long as eye; the blunt, stout first dorsal spine about half as long as head; three enlarged plates behind gill slit; eye placed very high up, almost flush with profile, and about half its diameter in advance of dorsal spine, which is over gill opening; on caudal peduncle are four rows of short recurved spines.

Snout and dorsal surface dusky, belly whitish; a dark inter-orbital band, which becomes blackish brown below eye, passes diagonally to base of pectoral; from gill slit and base of pectoral a very broad blackish brown band goes diagonally downward to anus and anterior three-fourths of anal fin; on caudal peduncle the acute angle of a black wedge-shaped band extends forward to a point opposite anterior third of soft dorsal and anal fins; paler above and below the dark wedge; first dorsal fin dark, the other fins all pale.

I have examined a specimen of this boldly marked species, 40 millimeters long, which was obtained at Cabalian, Leyte. It was previously collected by R. C. McGregor at Calayan Island, north of Luzon, as recorded by Jordan and Richardson.

This species is not very abundant in the East Indies, but occurs from the east coast of Africa throughout Polynesia, where it is common. Northward it ranges to Marcus Island and Honolulu.

Balistapus verrucosus (Linnæus).

Balistes verrucosus LINNÆUS, Mus. Ad. Frid. (1754) 57, pl. 27, fig. 4; Syst. Nat. ed. 10, 1 (1758) 328; BLEEKER, Atlas Ichth. 5 (1865) 120, pl. 216, fig. 2; GÜNTHER, Cat. Fishes 8 (1870) 225; Fische der Südsee 3 (1910) 444, pl. 170, fig. A.

Balistapus verrucosus JORDAN and RICHARDSON, Bull. U. S. Bur. Fisheries 27 (1907) 273.

Balistes prasinensis QUOY and GAIMARD, Voy. Uranie, Zool., 2° part. (1824) 205, pl. 46, fig. 1.

Balistes prasinoides LESSON, Voy. Coquille, Zool. 2 (1830) 117, Atlas (1826) Poiss. No. 9, fig. 3.

Local name: *Pugut gusu*, Tao Sug.

Dorsal III, 17-26; anal 22, 23. In a longitudinal series from gill slit to base of caudal rays there are from forty to forty-three scales, and in a transverse series from first dorsal spine to anus there are from twenty-four to twenty-five scales.

Depth contained about twice in length, while head is contained 2.6 to 2.75 times; snout about $\frac{1}{3}$ the length and about $\frac{2}{3}$ of length of head; eye, which is contained 4.3 to 5.3 times in head, is placed very high up, with its posterior margin nearly a diameter in advance of first dorsal spine and directly above lower or anterior end of gill slit; first dorsal spine broad, blunt, and quite variable in length, but when normally developed equal to half the length of head; there are three and a half rows of sharp, appressed spines, their points directed forward; behind gill slits are three or four enlarged bony plates; the very irregular lateral line is readily visible.

Upper half of alcoholic specimens varies from pale brown to blackish brown, underparts pale brown to white, with a very large black blotch extending from middle of side to anal region; above upper lip is a broad blackish or pale bluish band which extends backward from behind angle of mouth a short distance; above it is a narrow pale line which extends to base of pectoral; three wide dark bands upon interorbital space; in some they are bordered by narrow blue lines; the middle one descends from eye to base of pectoral, widest above and narrowing below; sometimes it has a central and two marginal blue lines; caudal peduncle pale with a black band extending downward from posterior end of soft dorsal, but not reaching anal; a black line on upper half of narrowest part of caudal peduncle, and a black band at posterior extremity of caudal peduncle across base of fin; caudal spines black; first dorsal spine very dark, rest of first dorsal and the other fins all pale or yellowish.

I have examined eight specimens from Iba, Zambales; Calapan, Mindoro; Cabasao, Camarines; Cabalian, Leyte; Zamboanga, Mindanao; and Jolo, varying in length from 33 to 110 millimeters. It has previously been recorded by Günther from the "Philippine Islands" and from "Zebu;" by Jordan and Richardson from Cagayancillo Island; and by Seale and Bean from Zamboanga. In my specimens from Zamboanga, which are 33 and 35 millimeters long, the proportions are different from those given, owing to the greater relative size of the eye. In the University of Santo Tomas Museum is a specimen about 170 millimeters long, labeled "N. de Luzon."

This variable but distinctly marked and easily recognized species is very common in the East Indies and ranges north to the Pelew Islands, and southeast to the Society Islands.

Tao Sug is the kind of Moro spoken by the people on Jolo Island.

Genus ABALISTES Jordan and Seale

Abalistes JORDAN and SEALE, Bull. Bur. Fisheries 25 (1906) 364.

Leiurus SWAINSON, Nat. Hist., Fishes 2 (1839) 326.

This well-marked genus is separated at once from all other Balistidæ by the peculiar caudal peduncle, which is thick and strongly flattened on the top and bottom, so that at the narrowest part its depth is much less than its breadth. The first dorsal spine is also longer, slenderer, and more pointed than in other Philippine Balistidæ. In other respects it agrees fairly well with *Balistes*.

Swainson's name cannot be used, as it is preoccupied.

Abalistes stellaris (Bloch and Schneider).

Balistes stellaris BLOCH and SCHNEIDER, Syst. Ichth. (1801) 476.

Leiurus stellatus BLEEKER, Atlas Ichth. 5 (1865) 105, pl. 215.

Balistes stellatus GÜNTHER, Cat. Fishes 8 (1870) 212.

Dorsal III, 27; anal 24 or 25. There are about forty-five scales in a longitudinal series and twenty-nine in a transverse series from first dorsal spine to anus.

Depth contained 2.35 to 2.5 times, head nearly 3.5 times in length; the convex snout from 0.75 to 0.8 of length of head and contained 4.3 times in length; the rather large eyes placed very high up and contained 4.4 to 4.5 times in head; the long, narrow, sharp-pointed first dorsal spine 3.75 times diameter of eye and slightly exceeds length of snout in one specimen; in others it is 3 times eye and a little more than 0.9 as long as snout; mouth terminal, with equal jaws and thick, fleshy lips; the central pair of teeth both above and below longer than the rest; gill slit beneath first dorsal spine, and behind it are five or six enlarged bony plates; ventral spine broad, stiff, and in one specimen immovable; in the others it is flexible; caudal peduncle strongly compressed dorsoventrally, the upper and lower surfaces broad and flat; depth of caudal peduncle at narrowest part from 0.6 to $\frac{5}{8}$ of its lateral diameter; five rows of scales on posterior half of trunk and on caudal peduncle more or less keeled; posterior margin of caudal somewhat wavy and the lobes produced into long filaments.

Color in alcohol pale bluish gray, gradually merging into white on belly; dorsal region may be more or less pale brown; there are few distinct markings; there are traces of large circular white spots on back; both dorsals, anal, and caudal are variously marked with alternate bands, stripes, or reticulations of white and bluish or brown.

Here described from a very poor specimen, 316 millimeters long, collected at Malampaya Sound in 1910 by W. Cameron Forbes, and from two fine specimens, 282 and 220 millimeters in length, collected at Basilan, August, 1923, by G. A. Lopez.

A very fine specimen, 250 millimeters long, has also been added to the collection from Estancia, Panay.

Young specimens are marked with more or less irregular blue lines on head, tail, and the region between pectoral and first dorsal, while on back are four large white spots. These spots and markings largely or entirely disappear in adult life.

This fine balistid, which reaches a length of more than 600 millimeters, has not been reported previously from the Philippines. It occurs from the Red Sea and the coast of Mozambique to the Fiji Islands.

Genus *MELICHTHYS* Swainson

Melichthys SWAINSON, Nat. Hist., Fishes 2 (1839) 325.

This genus is chiefly distinguished by having white, even, incisorlike teeth instead of the irregular pointed or notched teeth of *Balistes*. There is a groove before the eye, and the head is entirely covered with scales. The ventral flap is small, immovable, and covered with rough scales.

There is apparently but a single species, widely dispersed in the Indian and Pacific Oceans and also in the West Indies.

Melichthys radula (Solander).

Balistes radula SOLANDER, MSS. (1768) in Richardson, Voy Samarang, Fishes (1848) 21, pl. 6, figs. 1-4.

Balistes ringens OSBECK, Reise nach Ostind. (1765) 386, not of Linnæus.

Melichthys ringens BLEEKER, Atlas Ichth. 5 (1865) 108, pl. 220, fig. 2.

Balistes niger GÜNTHER, Fishes of Zanzibar (1866) 135, pl. 19, fig. 1.

Balistes buniva GÜNTHER, Cat. Fishes 8 (1870) 227.

Melichthys bispinosus GILBERT, Proc. U. S. Nat. Mus. 13 (1890) 125.

Melichthys radula JORDAN and EVERMANN, Bull. U. S. Fish Comm. 23 (1903) 417, pl. 64.

Dorsal II, 31; anal 27. There are sixty-one scales in a longitudinal series from gill slit to base of caudal rays and thirty-nine in a transverse series from first dorsal spine to anus.

Depth a trifle more than twice in length; head very deep, with projecting lower jaw, its length contained a little more than 1.5 times in its depth and 3.6 times in head and body together; snout convex, its length 1.3 times in head and 4.8 times in length; eye anterior to gill opening and contained 4.5 times in snout or about 6 times in head; gill slit slightly in advance of the wide, thick, blunt first dorsal spine, which is not serrate and is contained 1.7 times in head; four enlarged bony plates behind gill slit; eight rows of short sharp-pointed spines on sides, extending from middle of trunk back to posterior portion of caudal peduncle; caudal fin lunate, upper and lower lobes being moderately elongated.

This fish seems to be subject to variation in the number of dorsal spines and dorsal and anal fin rays. The first dorsal may have either two or three spines; the second may have from thirty-one to thirty-three rays, and the anal from twenty-seven to thirty.

Color in alcohol uniform deep black with very dark brown fins, and a white line on base of soft dorsal and anal fins; a very fine pale line parallel to and near posterior margin of caudal fin.

Here described from a specimen 283 millimeters long, without the deeply lunate caudal fin, collected by G. A. Lopez at Sibuyan. This species, which has not hitherto been recorded from the Philippines, is found in the Indian Ocean, from the Seychelles eastward throughout the tropical Pacific to the Revillagigedo Islands off the coast of Mexico. It is apparently rare in the Indian Ocean and the East Indies, but is very abundant at Marcus Island and the Revillagigedos, and is common at Honolulu. This is one of the most widely distributed coral-reef fishes and occurs also in the West Indies, where it is not very common. The *ringens* of Linnæus belongs to the genus *Xanthichthys*.

Genus *ODONUS* Gistel

Odonus GISTEL, Naturgesch. des Thierreichs (1848) XI.

This genus is differentiated from the other Balistidæ by the orange or red teeth, the two long and strongly projecting canines of the upper jaw, the large prominent chin, the large scales on the sides of the body, and the greatly prolonged caudal lobes. There is a groove in front of the eye, as in *Balistes*.

The genus was first recognized in 1835 by Rüppell, who called it *Xenodon*, a name preoccupied in reptiles. Swainson's misprint

of it in 1839 as *Zenodon* cannot be accepted as a valid substitute, while Rüppell's appropriate name of *Erythrodon*, proposed in 1852, is preceded by *Odonus*.

Odonus niger (Rüppell). Plate 1, fig. 2.

Balistes niger (*Baliste noir*) LACÉPÈDE, Hist. Nat., Poiss. 1 (1798) 335, 378, pl. 15, fig. 2.

Xenodon niger RÜPPELL, Neue Wirbelt., Fische (1835) 53, pl. 14, fig. 3.

Erythrodon niger RÜPPELL, Verzeich. Mus. Senck., Fische (1852) 34; BLEEKER, Atlas Ichth. 5 (1865) 106, pl. 219.

Balistes erythrodon GÜNTHER, Cat. Fishes 8 (1870) 228; DAY, Fishes of India (1878) 692, pl. 175, fig. 4.

Dorsal III, 32, 35; anal 28, 30. There are from thirty-three to thirty-five scales in a longitudinal series from gill slit to base of caudal fin and about twenty-two in a transverse series from first dorsal spine to anus.

Depth of the broadly ellipsoid body is half its length; head contained from 3.7 to 4 times in length, snout from 0.75 to 0.8 as long as head; eyes of medium size, their posterior margin slightly in advance of gill slit, in one specimen contained 3.6 times in head, in larger specimens from 5.4 to 5.8 times; first dorsal spine short, broad, and blunt, its length from 1.8 to 1.9 in head or from 2 to 3 times diameter of eye; three enlarged bony plates behind gill slit.

The rounded prominent chin extends considerably beyond mouth; teeth red, irregular, upper jaw with a pair of strongly projecting canines which overlie lower lip and are much longer than the pair of central incisors between them; scales on sides of body noticeably large, those on posterior half of body and caudal peduncle more or less keeled or spinous tuberculate, in about seven longitudinal rows; soft dorsal and anal elevated anteriorly, anterior margin convex; upper and lower marginal lobes of the deeply lunate caudal greatly produced, length of caudal proper but 0.2 of that of the elongated caudal filaments.

The color in life of a specimen 173 millimeters long, obtained by Alvin Seale at Sitanki in 1908, was a beautiful uniform deep blue, the soft dorsal and anal darker, approaching violet, with a violet longitudinal band along base; the membrane of first dorsal was brownish orange, the caudal sky blue.

This specimen, after being fourteen years in alcohol, is nearly uniform brownish, with a very narrow whitish line along posterior margin of caudal fin.

Two specimens obtained in 1921 near Olongapo, 241 and 261 millimeters in length, respectively, are uniform blue-black, with blue caudal fin; the free tips of the soft dorsal and anal rays are paler than the body of the fins; a very narrow white line forms the posterior margin of the caudal.

The specimens listed above are the first recorded from the Philippines. This well-marked species, easily recognizable at first glance, is found from the Red Sea, Mombasa, and Ile de Réunion, to the Society Islands in the South Pacific, though it does not seem to be abundant anywhere.

The name at Sitanki is *epet*.

MONACANTHIDÆ

FILEFISHES: FOOLFISHES

This family is closely related to the Balistidæ, but differs fundamentally in having the first dorsal reduced to a single spine. The species are only moderately numerous and are mostly small herbivorous fishes of the coasts of tropical seas, though two of the genera contain rather large fishes which are found in all warm seas. Like the Balistidæ, the Monacanthidæ should not be used for food, as their flesh is not only thin, hard, and more or less bitter, but usually also contains poisonous alkaloids which cause ciguatera and death, if much is eaten.

The body is laterally much compressed, and the tough skin is covered with small to minute scales which are more or less spine-bearing, so that it is usually like fine sandpaper or very fine emery paper to the touch; hence the name filefish. Some of the species are dimorphic, the sexes being quite different in external appearance, and the males sometimes with bunches of long needlelike or stout spines on the caudal peduncle. The first dorsal is composed of a single strong spine, which may have a rudimentary one behind it; the second dorsal and anal are both long and of similar outline; the ventral fins are reduced to a single small bony appendage at the end of the long pelvic bone, which may be either fixed or movable, but may often be rudimentary or entirely absent; the vertebræ are 7 + 11 to 14, or a total of 18 to 21.

The mouth is small, with six incisorlike and often irregular teeth in each jaw, those of the lower jaw fitting inside the upper teeth when the mouth is closed. I cannot agree with authors who state that the upper jaw has a double series of

teeth; upon extracting a tooth I find it to have an inner lamina or cusp with a grinding surface, as in the Balistidæ, but this is an integral part of the tooth; there is, therefore, a single row of teeth in the upper row, some of which appear like two teeth on a cursory examination. Six genera and twelve species of this family are here recorded from the Philippines.

Key to the Philippine genera of Monacanthidæ.

*a*¹. Dorsal spine over eye.

*b*¹. Pubic bone with a small spine at its tip; gill opening short, nearly vertical; dorsal and anal moderate in length, each with less than forty rays.

*c*¹. Snout not greatly elongated, without tubular tip.

*d*¹. Ventral spine jointed, movable; dorsal spine armed with barbs.

*e*¹. Abdomen with a wide thin finlike flap with branched supporting rays and extending far beyond pelvic spine. *Monacanthus*.

*e*². Ventral flap little developed, not finlike. *Stephanolepis*.

*d*². Ventral spine immovable; dorsal spine with or without barbs.

Cantherines.

*c*². Snout greatly elongated, with tubular tip. *Oxymonacanthus*.

*b*². No ventral spine; gill opening long, very oblique; dorsal and anal long, each with forty-five or more rays.

*f*¹. Caudal fin nearly truncate, shorter than head; snout convex.

Alutera.

*f*². Caudal fin very long, with rounded angles; snout concave.

Osbeckia.

*a*². Dorsal spine on snout forward of eye, gill opening behind eye.

Pseudaluteres.

Genus **MONACANTHUS** Cuvier

Monacanthus CUVIER, Regne Anim. ed. 1 (1817) 152.

This genus includes several species of small or medium-sized fishes found in the tropical and warm temperate seas. All have a short, deep, and very strongly compressed body, the leathery skin covered with minute but rough scales, often reduced to shagreenlike prickles, and the lean, hard, bitter flesh is unfit for food. The mouth is very small, the snout longer than the head, its profile more or less concave; the gill opening is a small slit directly beneath the circular eye, its anterior or lower end just in front of the upper edge of the pectoral. The large dorsal spine is without conspicuous filaments, but has two rows of stout, hooked, downward-pointing barbs on the rear and may or may not have two closely set rows of much smaller barbs on the front side. The soft dorsal and anal are alike, of twenty-five to thirty-five rays each; the caudal fin is of moderate size, its free end rounded; the pelvic bone ends in a blunt, movable

spine and is connected to the abdomen by a very large, wide, movable flap or dewlap which extends like a fin far beyond the body line, and is supported by branched flexible rays resembling fin rays; spines are often present on the sides of the caudal peduncle, especially in males. The vertebræ are 7 + 11 to 14, a total of 18 to 21. Only one species is known from the Philippines.

Monacanthus chinensis (Bloch). Plate 1, fig. 3.

Balistes chinensis BLOCH, Ichth. 5 (1787) 26, pl. 152, fig. 1; OSBECK, Iter Chinensis (1757) 147.

Monacanthus chinensis BLEEKER, Atlas Ichth. 5 (1865) 125, pl. 222, fig. 2; GÜNTHER, Cat. Fishes 8 (1870) 236; JORDAN and FOWLER, Proc. U. S. Nat. Mus. 25 (1902) 262.

Dorsal I, 29; anal 29. This exceedingly deep and compressed fish is distinguished at a glance by the peculiar form of the body with its great ventral flap like a huge pendulous dewlap, and by its distinctive coloration. The depth at the origin of the soft dorsal is contained 1.85 times in length, and the depth measured at its greatest extent is contained about 1.25 times in length; the small, pointed, rather short head is contained 4 times in length and both snout and throat are concave; snout more than 0.8 as long as head; eyes high up, their diameter about $\frac{1}{3}$ of snout and 3.68 times in head; interorbital space very high and convex; mouth small, and opposite upper part of gill opening; lips smooth and rather broad, with chin slightly projecting; the moderately stout and rather short dorsal spine armed behind with two rows of strong recurved spines and inserted over posterior half of eye, its length 1.6 times in head; gill slit about 0.25 longer than an eye diameter and extending diagonally upward and backward from in front of upper part of pectoral to a point slightly posterior of hind margin of eye; soft dorsal and anal both well developed, the middle rays longest, those of anal reaching a length approximately $\frac{2}{3}$ that of head; length of caudal equal to that of head, first or upper ray elongated, the free margin convex; when expanded caudal very broad, its length contained $1\frac{1}{2}$ in its depth; abdomen developed into a very wide, thin flap which extends below body contour proper much farther than do the anal rays; this flap is supported by many long, slender, cartilaginous stays which look like fin rays; ventral spine long, jointed, and movable; ventral region above the finlike portion very roughly striated with tubercular lines and ridges; caudal peduncle very rough

and on each side it has two rows of large spines curved forward, with three in each row; body everywhere covered with very small spinescent scales, so that it feels like rough sandpaper.

Color in alcohol light brown, mottled and irregularly banded with dark brown; at least two wide irregular bands pass diagonally forward from soft dorsal to ventral side; entire body sprinkled with dark or blackish brown dots; six longitudinal rows of very small dark spots on soft dorsal and a polygonal network of dark lines on anal; a similar network, more or less broken into spots, on outer portion of finlike ventral expansion; caudal has a wide basal blackish band, then a very wide paler band, then another band of blackish brown, and a pale margin; the whole fin marked by narrow transverse lines of dark brown and everywhere sprinkled with fine dark dots; the pectoral colorless.

Here described from a specimen 185 millimeters long, or 230 millimeters in total length, collected at Culion Island. I have also examined thirteen other specimens, varying in length from 22 to 170 millimeters, collected at Bulan, Sorsogon; Bantayan Island; Zamboanga and Davao, Mindanao; Balabac Island; and Sandakan, Borneo. Several of these specimens lack spines on the caudal peduncle. Three specimens from Davao are very small, being only 22 to 25 millimeters long, and are quite unlike other specimens in their proportions; the most conspicuous difference is in their depth, which is nearly or quite equal to their length; their coloration is not very distinctive, but the two large diagonal dark bands can be made out and the whole body is conspicuously though sparsely sprinkled with large dark dots. The caudal peduncle in these three specimens has a patch of very long stiff bristles directly in front of the caudal fin, their free tips extending upon the fin; this character is evidently soon lost, for in one of these juvenile specimens one side has already lost the bristly hairs and has the characteristic spines, though of course they are still very small.

This species has been recorded from Manila and from Negros Island by Jordan and Seale, and from Bulan, Sorsogon, by Evermann and Seale, and undoubtedly occurs around reefs in all parts of the Philippines. It is common on the shores of the China Sea and the Malay Peninsula, and occurs from Pinang and Singapore eastward to Celebes and the Moluccas, and north to the Riu Kiu Islands.

There are two specimens from northern Luzon in the University of Santo Tomas Museum.

Genus **STEPHANOLEPIS** Gill

Stephanolepis GILL, Proc. Acad. Nat. Sci. Philadelphia (1861) 78.

In *Stephanolepis* the ventral flap does not form a pendulous dewlap and extends very little beyond the ventral spine, even in the adult; the surface of the flap is rough, with modified scales, and no finlike rays are visible except upon dissection. The caudal peduncle is usually smooth or it may have bristly spines. Most of the monacanthids belong to this genus, which differs from nearly related genera principally in the size and structure of the ventral flap. The species are all small.

* *Key to the Philippine species of Stephanolepis.*

- a¹. Caudal peduncle with bristly spines on each side..... *S. tomentosus*.
- a². Caudal peduncle without bristles or spines.
- b¹. Dorsal with twenty-six rays; a large dark spot below anterior half of soft dorsal; profile of snout straight..... *S. cryptodon*.
- b². Dorsal with thirty rays; gill slit in a velvety blackish spot; snout concave *S. melanocephalus*.

***Stephanolepis tomentosus* (Linnaeus). Plate 1, fig. 4.**

Balistes tomentosus LINNÆUS, Syst. Nat. ed. 10 1 (1758) 328.

Monacanthus tomentosus BLEEKER, Atlas Ichth. 5 (1865) pl. 220, fig. 1, masc., pl. 229, fig. 1, female; JORDAN and RICHARDSON, Bull. Bur. Fisheries 27 (1907) 272.

Monacanthus nemurus JORDAN and SEALE, Bull. Bur. Fisheries 26 (1906) 36.

Local name: *Bitig*, Tao Sug.

Dorsal I, 26–29; anal 25–28. Measured from origin of soft dorsal to anal, depth contained from 1.65 to twice in length, in most of my specimens about 1.9 times; the pointed head contained from 3.15 to 3.3 times in length; the concave snout contained from 1.3 to 1.45 times in head; the large circular eyes high up, a diameter below the convex interorbital space, and contained from 2.6 to 3.25 times in head and from 1.8 to 2.37 in snout; the nearly vertical gill slit lies between upper anterior corner of pectoral and posterior half of eye, its upper end sometimes extending a trifle behind a vertical from rear margin of eye; the stout, backward-curved dorsal spine placed over posterior half of eye and usually a little shorter than head, though occasionally a trifle longer; on angles of posterior side of spine are two rows of less than ten each of strong, downward-curved, hooked barbs; anterior surface may be smooth or more or less roughened, or with a few feebly developed barbs; ventral spine free, movable, and armed with stout, strongly recurved barbs on each side; soft dorsal and anal rather low, their middle rays

highest; posterior margin of the large caudal fin convex, its length nearly or quite a fourth of that of head and trunk together; body everywhere covered with very small scales, each bearing from three to five tiny rigid sharp spines on posterior margin, the central one usually the longest; when stroked toward the tail the skin feels more or less velvety, but if stroked in the opposite direction it is very harsh, like the coarsest sandpaper; on each side of caudal peduncle is an oblong or elongated patch of bristly spines of greater or lesser length; they may be very conspicuous in males but small or absent in females or young.

Color in alcohol varies from brownish gray to dark brown, more or less mottled with streaks and blotches of darker or blackish brown; a broad irregular whitish band, with a dark blotch above and below it, is usually present on sides, extending from behind gill opening to a point above anus; caudal fin has two broad dark crossbands; the other fins are colorless.

The above description is based upon an examination of twenty-one specimens, varying in length from 35 to 85 millimeters, obtained in the following localities: Puerto Galera and Calapan, Mindoro; Bantayan Island; Dicuayan Island, Bu-suanga; Cuyo Island; Puerto Princesa, Palawan; Dumaguete, Oriental Negros; Zamboanga and Caldera Bay, Mindanao; Samal Island, Davao, Mindanao; Jolo; Balabac. The largest specimen, one from Puerto Princesa, Palawan, has a length over all of 105 millimeters.

A specimen from Samal Island was bluish grass green when fresh, darker above and paler below; the snout was thickly sprinkled with black dots, which also occurred behind eyes and along sides; a broad band of soft white passed backward from behind gill slit to a point beneath origin of soft dorsal, where it curved upward above level of top of caudal peduncle; a narrow blotch of weak black above anterior half and a more rounded one under the middle of the white band; a short longitudinal bar of white behind eye; three small bands of very pale evanescent sepia on the yellowish throat and breast; the spinous dorsal dark, with pale brown membrane; the rays of the soft dorsal and anal were reddish, the membranes colorless; the rays of caudal bright grass green, the membranes brownish, with a black spot on the two upper and the two lower membranes; a narrow marginal dark band followed by a narrow white one similar to the lateral band and then another narrow dark band; all three evanescent and incomplete or not well defined.

In the Bureau of Science collection is a specimen without label (unquestionably from the Philippines and probably from Calapan, Mindoro), which has the body covered with exceedingly small scales with here and there pale threadlike fibrils scattered over head and body; the filaments are most numerous on ventral half of body, the longest ones about the diameter of an eye in length; no patch of spiny fibrils on caudal peduncle. Aside from the greater fineness of the scales and the presence of the fibrils on the body, the specimen is typical of *M. tomentosus*.

I also refer here twenty-six young specimens collected by E. H. Taylor on the southern coast of Cotabato Province, Mindanao; they are all small, from 35 to 44 millimeters in length, and lack the bristly spines on the caudal peduncle and also the whitish band on the side.

This insignificant species is found about coral reefs throughout the central and southern Philippines and has been reported by Jordan and Seale from Manila and Panay Island; by Jordan and Richardson from Lubang Island and from Cuyo; and by Vaillant from Palawan. At Cuyo it is called *pagnesan* and by the people of Samal Island it is known as *peleg*.

A common East Indian fish, said to range from Singapore to the northern coast of Australia, and northward to the coast of China.

Stephanolepis cryptodon (Bleeker).

Monacanthus cryptodon BLEEKER, Nat. Tijdschr. Ned. Ind. 8 (1855) 431; GÜNTHER, Cat. Fishes 8 (1870) 233.

Paramonacanthus cryptodon BLEEKER, Atlas Ichth. 5 (1865) 131, pl. 225, fig. 1.

Dorsal I, 26; anal 26. Depth at origin of soft dorsal contained 2.25 in length, and head 3.3 times; profile forms a straight line from dorsal spine to top of snout, which is 0.25 of the length and is contained 1.2 times in head; the circular eyes high up, a half diameter below profile, and contained $2\frac{1}{2}$ times in snout and 2.8 times in head; the slightly oblique gill slit a little shorter than eye and lies wholly beneath posterior half of eye; the slightly curved, sharp-pointed, and rather slender dorsal spine is over posterior half of eye and contained 1.3 times in head; on either side of posterior part of spine is a row of six or eight feebly developed downward-pointing prickles; ventral spine small, slender, movable, and armed with a few very small, straight spinelets; soft dorsal highest anteriorly, the

longest rays a little greater than an eye diameter; anal similar in outline, but lower; length of caudal fin 0.25 of that of head and body together, its posterior margin convex; head and body covered everywhere with minute scales, which feel like fine sandpaper; no spines or bristles on caudal peduncle.

Color in alcohol of a badly faded specimen brown, throat and belly pale, with a large blackish brown spot on each side below anterior half of soft dorsal; there are traces of dark bands on throat and of dark brown blotches and marblings on head and body; there are also indications of small dark spots sprinkled over body; there is a dark spot behind soft dorsal and anal fins, on caudal peduncle; dorsal spine brown barred, with a whitish tip, its membrane very pale brown; caudal brown, with two dark crossbands; the other fins are all pale.

I have referred here a small, poorly preserved specimen, 56 millimeters long, collected at Balayan Bay, Batangas, in 1908. It differs from typical *Monacanthus cryptodon* in having two rows of poorly developed barbs on the dorsal spine, instead of being merely rough.

This species has been known hitherto only from Bleeker's collections in Celebes and Amboina. It is close to *Monacanthus choirocephalus* and *M. nemurus*, but differs in the smaller number of dorsal and anal rays, the shape of the profile, the position of the eye, and the coloration.

Stephanolepis melanocephalus (Bleeker).

Monacanthus melanocephalus BLEEKER, Nat. Tijdschr. Ned. Ind. 5 (1853) 95, Atlas Ichth. 5 (1865) 127, pl. 223, fig. 1; GÜNTHER, Cat. Fishes 8 (1870) 242.

Balistes monoceros LACÉPÈDE, Hist. Nat. Poiss. 1 (1798) pl. 17, fig. 3 (the description only in part).

Monacanthus janthinosoma BLEEKER, Nat. Tijdschr. Ned. Ind. 6 (1854) 504.

Dorsal I, 30; anal 27. Depth of body, measured from origin of soft dorsal to anal, contained nearly 2.2 times in length, while the extreme depth across ventral flap is 1.7 times in length or twice in the total, including caudal fin; the pointed head is 3.18 times in length and the strongly concave snout 1.3 times in head; the moderately large and circular eye placed high up, very close to dorsal spine, its diameter contained 3.14 times in snout; gill slit extends diagonally upward and backward from in front of upper end of base of pectoral, but lies wholly under eye, its length $\frac{5}{7}$ of diameter of eye; the long, stout, erect dorsal spine is directly over center of eye, its length nearly equal

to that of head, and has about twelve downward-pointing stout spines on each side; back smooth, front rough, with two rows of small, closely set, upward-pointing spines on upper portion; soft dorsal and anal much the highest anteriorly, the rays there nearly twice as long as the posterior ones; caudal peduncle noticeably wide and short; ventral flap of moderate width, surface diagonally ridged and rough, ventral spine well developed, free, and movable, armed with strong sharp-pointed spines; the broad caudal fin 0.2 as long as head and body together; body covered with small to minute scales; those on chin and belly blunt and rounded, the rest each with a single hard sharp spine, longer and better developed on the scales of posterior part of caudal peduncle.

Color in alcohol brown, very dark above, paler ventrally, with a velvety blackish brown spot around gill opening; ventral flap with a dark brown band marginally; rays of caudal fin dark brown basally, becoming lighter toward their tips; several alternate blackish and pale lines at the free end; soft dorsal, anal, and pectoral fins all pale.

Here described from a specimen 70 millimeters long, collected in January, 1921, at Calapan, Mindoro. This distinct and easily recognized species, not heretofore recorded from the Philippines, is known only from the Dutch East Indies.

Genus *CANTHERINES* Swainson

Cantherines SWAINSON, Nat. Hist. Fishes 2 (1839) 327.

This genus much resembles *Monacanthus*, the chief difference being that the ventral spine is fastened immovably to the pelvic bone. The dorsal varies; in some species it is merely roughened and in others it has four rows of more or less well-developed barbs, there being every gradation between.

Key to the Philippine species of Cantherines.

- a*¹. Scales relatively coarse; scattered cutaneous filaments on sides of body *C. macrurus*.
- a*². Scales finer than in *macrurus*; body without cutaneous filaments.
- b*¹. No spines on caudal peduncle.
 - c*¹. Scales minute, those before caudal fin bristly or hairy; snout as long as head; eyes 3.5 to 3.75 in head; color dark with a faint paler network..... *C. pardalis*.
 - c*². Scales not distinct; snout 1.25 in head; eyes 2.3 in head; color brown with squarish darker spots in regular longitudinal and transverse rows..... *C. tessellatus*.
- b*². Caudal peduncle usually with four spines in two rows of two each; color very dark without network or regularly arranged spots.
 - C. sandwichiensis*.

Cantherines macrurus (Bleeker). Plate 2, fig. 1.

Monacanthus macrurus BLEEKER, Nat. Tijdschr. Ned. Ind. 12 (1856-57) 226; GÜNTHER, Cat. Fishes 8 (1870) 247.

Pseudomonacanthus macrurus BLEEKER, Atlas Ichth. 5 (1865) 134, pl. 228, fig. 2.

Cantherines macrurus JORDAN and SEALE, Proc. U. S. Nat. Mus. 28 (1905) 790; EVERMANN and SEALE, Bull. Bur. Fisheries 26 (1906) 100.

Local name: *Bungaong*, Sulu moro.

Dorsal I, 29-30; anal 27-29. The depth of the elongate and strongly compressed body is from twice to more than 2.25 times in length; head not greatly produced and contained from 3.3 to 4.3 times in length; the concave snout a little longer than head, or in young specimens of the same length, 3.75 to 4 times in length; the large eyes placed very far back and high up and contained about 2.5 times in head; gill openings are smaller than eyes and extend farther forward than anterior margin of eye, except in very young specimens, when they lie wholly beneath the eye; the spinous dorsal is over posterior half of eye, its length $1\frac{1}{2}$ to $1\frac{3}{4}$ times in head; two rows of strong hooked barbs on posterior side; those on front of spine much smaller and so close together as to appear like one row; ventral spine small, rough, and immovable; body covered everywhere with distinctly visible spinescent scales, much coarser than in the other species of *Cantherines*, with very few to many threadlike or stringy filaments scattered over sides of body; caudal fin longer than head or snout, its free end rounded; dorsal and anal fins low; on lower half of caudal peduncle are two or three sharp-pointed spines with tips recurved forward; these spines are difficult to see in some specimens and in the very young are altogether absent, but with age they become large, strong, and very plainly evident.

In alcohol the color varies from brownish gray to olive brown, with many small circular dark brown dots scattered over entire surface; on chin and breast are three or four dark transverse bands and over sides and back are diagonal irregular dusky bands and blotches; the rays of caudal fin are dark with dark transverse bands; the soft dorsal, anal, and pectorals are all pale.

I have examined six specimens of this little fish from the following localities: Bacon, Sorsogon, length 112 millimeters; Calapan, Mindoro, 119 millimeters; Bantayan Island, 127 milli-

meters; Balabac, 62 millimeters; Dicuayan Island, Busuanga, 45 and 43 millimeters.

The Balabac specimen was painted from life by T. S. Espinosa, in 1908, and had the following colors: The whole body was olive brown with a patch of yellow on the chin and darker olive on the top of the head, back, and along the caudal peduncle; the whole body with circular, very dark olive spots thinly scattered over it; the soft dorsal and anal rays were bright orange, the membranes colorless; pectoral nearly colorless, with a slight tinge of yellow basally; the basal half of the caudal rays olive green, their outer half olive brown; the membranes dark olive brown with a broad dark band posteriorly and a narrow one across the middle of the basal half; the tip of the ventral flap dark with half transparent greenish white spines.

Cantherines pardalis (Rüppell).

Monacanthus pardalis RÜPPELL, Neue Wirbelt., Fische (1835) 57, pl. 15, fig. 3; GÜNTHER, Fische der Südsee 3 (1910) 498, pl. 169, fig. B; Report Shore Fishes, Zool. Voy. Challenger 1^o (1880) 54.

Liomonacanthus pardalis BLEEKER, Atlas Ichth. 5 (1865) 136, pl. 230, fig. 2.

Dorsal I, 34–36; anal 30–31. Body strongly compressed laterally and much extended ventrally, depth contained from 1.8 to 1.85 times in length; the pointed head contained from 3.6 to 3.68 times in length; the circular eyes rather large, their diameter contained from 3.5 to 3.75 times in head, and placed high up and very far back, so that the elongated, slightly concave snout is as long as head; interorbital space very convex; lips broad but rather thin, mouth small, and the irregular, pointed white teeth have more or less brownish tips; gill slit slightly oblique, its length less than 0.25 greater than an eye diameter; first dorsal spine above the forward half of eye, long, rather slender, without barbs but moderately roughened, its length equal to or 1.2 times in head; a rudimentary spine concealed behind dorsal spine; dorsal groove deep anteriorly, but shallow posteriorly; soft dorsal and anal similar in outline, both a little elevated anteriorly; posterior margin of caudal convex; pelvic spine not movable; skin everywhere covered with very small, minutely spinescent scales which are velvety when stroked toward tail, but like fine sandpaper when rubbed in the opposite direction; on sides of caudal peduncle a little before fin the scales have longer spiny processes, so that the region seems to

be covered with minute hairs or bristles; no spines on caudal peduncle.

This species possesses to a remarkable degree the power to change its color to conform with its environment. A living specimen in the Bureau of Science Aquarium, taken at Calapan, Mindoro, is a very dark brown, with a faint polygonal or hexagonal pale network over body; on sides of head are very faint wavy lines which converge toward mouth; soft dorsal and anal rays are pale reddish orange and caudal brownish yellow; pectoral colorless, with a very dark brown or black base.

When bothered for some time the fish crept under the overhanging margin of a valve of a small *Tridacna* and immediately changed its color to match the greenish cement behind it; no other color was present except a broad black bar between and including the eyes, and a black bar at the base of each pectoral. Upon being further disturbed, the fish after a while came to rest in a side angle of the tank and this time was a peculiar gray or slate color, with irregular vertical crossbands of dirty white, which were more evident on the ventral portion than on the sides; around the mouth and head the bands formed rings, completely encircling them; two white bands on the caudal peduncle were also very distinct; both eyes and the interorbital space were covered by a broad black band; there was a short black bar at the base of the pectoral and a black stripe along the base of the second dorsal; the fins were all very pale except the caudal, which was barred like the body, but was mostly slate color. When the fish was forced to leave, the white faded out, especially toward the caudal which became nearly all slate, and then the original color was resumed. In each instance the color changes were made with very great rapidity, especially when returning to the normal color.

In alcohol the color is uniform dull brownish gray with the polygonal pale network on body showing faintly and the interspaces evident as dark spots; the wavy lines on head are more or less distinct; the membrane of first dorsal and caudal rays is dark brown or colored like body; the remaining fins are all pale.

I have examined two alcoholic specimens, from Zamboanga, Mindanao, and Calapan, Mindoro, having lengths of 125 and 130 millimeters, respectively. The latter, collected in January, 1921, is a female containing eggs. The only previous Philippine record is that of the Challenger Expedition, a single specimen having been obtained from reefs at "Zebu," or Cebu.

Since the above was written E. H. Taylor has collected two specimens, 57 and 77 millimeters long, on the southern coast of Cotabato Province, Mindanao.

It is very interesting to observe living specimens. The long dorsal spine is repeatedly folded and unfolded, being now invisible in its groove and again held rigidly erect; sometimes while erect it is vibrated very rapidly through a small arc. Most of the time locomotion is accomplished solely by means of the rapid undulations of the long soft dorsal and anal, the caudal being held motionless.

Originally described from the Red Sea, this species is known also from Zanzibar, and eastward to the Society Islands.

Cantherines tessellatus (Günther).

Monacanthus tessellatus GÜNTHER, Report Shore Fishes, Zool. Voy. Challenger 1^o (1880) 54, pl. 23, fig. B.

Cantherines tessellatus JORDAN and RICHARDSON, Check List of Philippine Fishes (1910) 44.

D. 36, A. 32. Skin velvety, without distinct scales. The depth of the body is one half of the total length (without caudal). Snout long, the distance of the eye from its extremity being two-sevenths of the total length (without caudal). Upper profile very slightly concave. Gill opening below the middle of the eye; root of the pectoral below its posterior half. Dorsal spine rather long, nearly half as high as the body, above the posterior half of the eye, armed with four rows of barbs, of which the anterior are close together. Caudal with the margin rounded. Dorsal and anal fins but little higher anteriorly than posteriorly. Ventral spine small, fixed. Color light brownish. Head and body ornamented with squarish dark brown spots, regularly arranged in transverse and longitudinal series; caudal blackish. Philippine Islands. Length of specimen, 5 inches. Station 204; 115 fathoms.—Günther.

In Günther's figure, the snout is contained 1.25 times in head, eyes 2.3 times in head and 1.85 times in snout, and first dorsal spine 1.35 times in head.

Only one specimen is thus far known. Station 204 B, where the *Challenger* caught it by trawling, is off the eastern coast of Banton, an island in the Sibuyan Sea.

Cantherines sandwichiensis (Quoy and Gaimard). Plate 2, fig. 2.

Balistes sandwichiensis QUOY and GAIMARD, Voy Uranie, Zool. (1824) 124.

Cantherines sandwichiensis FOWLER, Proc. Acad. Nat. Sci. Phila. (1900) 514; JORDAN and EVERMANN, Bull. U. S. Fish Comm. 23 (1903) (1905) 418, fig. 183; JORDAN and RICHARDSON, Bull. Bur. Fisheries 27 (1907) 272.

Cantherines carolae JORDAN and MCGREGOR, in Jordan and Evermann, Bull. 47, U. S. Nat. Mus. 2 (1898) 1713; JORDAN and MCGREGOR, Report U. S. Fish Comm. 24 (1898) (1899) 281, pl. 6.

Monacanthus carolae GÜNTHER, Fische der Südsee 3 (1910) 449.

Monacanthus (*Cantherines*) *sandwichiensis* WEBER, Fische der Siboga Exp. (1913) 579.

Dorsal I, 35; anal 31. The oblong, moderately elevated body much compressed laterally, its depth 1.75 times in length; head rather long and pointed and contained 3.5 times in length or about twice in depth; snout a little shorter than head, being 0.93 of length of latter; anterior profile slightly concave, except over eye, where it is convex; from dorsal spine to caudal peduncle the dorsal outline is a long low curve; anal outline exactly similar; from just behind chin the outline is slightly convex to ventral spine; from this point to anal is a straight line; mouth small, lips thin, with the teeth of lower jaw fitting inside upper in closed mouth; tips of the dingy whitish teeth brownish; eyes high up with a strongly convex interorbital space; gill slit directly beneath eye and slightly oblique, its lower or anterior end in front of upper part of base of pectoral, its length greater than diameter of eye.

Surface of body everywhere like sandpaper when stroked toward head, or like very fine sandpaper when rubbed toward tail; dorsal spine inserted slightly in advance of middle of eye, moderately stout, and rougher than body, its length $\frac{2}{3}$ of head; anterior rays of soft dorsal and anal more elongated than posterior ones; posterior end of caudal fin convex; pelvic spine very short, rough, stiff, and immovable; no spines on caudal peduncle in my specimen; it is stated that males have two rows, each of two short recurved spines, on each side of caudal peduncle.

In alcohol the entire animal is uniform dull brownish plum color; the dorsal spine is dusky, with dark brown membrane; the pectorals, soft dorsal, and anal are very pale, slightly tinged with yellowish.

Here described from a specimen collected in Balabac in 1908, by Alvin Seale. This specimen was drawn in color from life by T. S. Espinosa. The whole body was uniform purplish black; the rays of the soft dorsal and anal were orange, the membranes colorless; the caudal rays were very dark blackish brown, the membranes light yellowish brown; the dorsal spine was the same color as the body, its membrane umber; the pectoral was pale greenish yellow; teeth whitish.

Jordan and Richardson listed three small specimens from Romblon Island, and Max Weber collected one at Sanguisiapo, an islet off the southwest coast of Tawitawi.

This species is abundant at Hawaii, and in the Revillagigedo Archipelago, off the coast of Mexico, where *C. pardalis* seems to be lacking. It is evidently not common in the Philippines or the East Indies, though it is said to occur in the Indian Ocean as far to the west as Mauritius.

Genus OXYMONACANTHUS Bleeker

Oxymonacanthus BLEEKER, Atlas Ichth. 5 (1865) 100 and 137; Ned. Tijdschr. Dierk. 3 (1866) 13, not p. 16 as in Jordan's Genera 3 (1919) 340.

Body oblong, the back not angular. Length of head greater than its depth, snout exceedingly long, narrow, and sharp pointed, the end tubular and the small mouth not terminal but opening upward; dorsal spine inserted over middle of eye, and lightly armed with spinelets; ventral spine immovable; caudal peduncle compressed, the narrowest part much higher than wide; skin slightly rough, with a patch of small bristles on caudal peduncle in males.

Only a single species is known, confined to the tropical waters of the Indian and Pacific Oceans.

Oxymonacanthus longirostris (Bloch and Schneider). Plate 2, fig. 3.

Balistes hispidus var. *longirostris* BLOCH and SCHNEIDER, Syst. Ichth. (1801) 464.

Monacanthus longirostris CUVIER, Regne Anim. ed. 1, 2 (1829) 152; GÜNTHER, Cat. Fishes 8 (1870) 233; Fische der Südsee 3 (1910) 450.

Monacanthus chrysospilus BLEEKER, Nat. Tijdschr. Ned. Ind. 4 (1853) 126.

Oxymonacanthus chrysospilus BLEEKER, Ned. Tijdschr. Dierk. 2 (1865) 143.

Oxymonacanthus longirostris BLEEKER, Atlas Ichth. 5 (1865) 137, pl. 224, fig. 1; JORDAN and SEALE, Bull. Bur. Fisheries 25 (1905) 365, pl. 50, fig. 2.

Dorsal I, 31 to 33; anal 29 to 31.

Scales minute, rough, the spinules being a little longer on the sides of the tail. Body oblong, its depth being one-third of the total length (without caudal). Snout much produced and pointed, the upper and lower profiles being nearly equally oblique. Dorsal spine rather strong, straight,

rough, rather shorter than the snout, inserted above the middle of the eye. Caudal fin rounded, short. Ventral spine not moveable, attached to the abdomen by a single membrane; dorsal and anal fins low. Bluish or greenish, with more or less regular series of rounded reddish, dark-edged spots, which are larger than the spaces of the ground color between them. Sometimes a vertical black spot on the posterior half of the caudal fin; sometimes small, white, brown-edged ocelli above the ventral spine.—*Günther*.

A specimen of this unique and brilliantly colored little fish was obtained by Seale at Samal Island, in Davao Gulf, in 1908; but it seems to have been either lost or misplaced, as I have been unable to locate it in the Bureau of Science collection. A colored drawing by T. S. Espinosa shows it to have been 42 millimeters long, or 52 millimeters long over all. The body was blue, darkest on the upper part of the head and very pale blue on the caudal peduncle, with about six longitudinal rows of elongated orange spots on the body and similar stripes on the head converging toward the pointed, white-tipped snout; the soft dorsal and anal fins were nearly colorless, each with a narrow yellow band along the base; the first dorsal spine was a trifle darker, with a very pale brown membrane; the ventral spine was brown; the rays of the caudal were bluish white, the membrane yellowish white, with a large black blotch on the lower half of the posterior portion of the fin.

This fish, different in shape and in its gaudy colors from all other filefishes, has not hitherto been recorded from the Philippines. It occurs from Mauritius eastward to Guam and the islands of the South Pacific.

Genus *ALUTERA* (Cuvier) Oken

Les Alutères CUVIER, *Regne Anim.* ed. 1, 2 (1817) 153.

Alutera OKEN, *Isis* (1817) 1182.

The large, elongate, thin, and strongly compressed body is covered with minute scales; head obtuse, snout short and convex; mouth and teeth much like those of *Monacanthus*, but the lower jaw a little projecting; gill opening an oblique slit, longer than eye, and below and forward of eye, its posterior end behind base of pectorals; pelvic bone long, sickle-shaped, movable under the skin, and without spine at its tip; the small, rough, barbless dorsal spine inserted above eye; soft dorsal and anal long, each with from forty-five to fifty rays; caudal peduncle narrow, its width 3 to 4 times in snout; caudal fin shorter than head, its pos-

terior extremity nearly truncate, the middle rays but little elongated.

The coloration is uniform brown, mottled with darker brown. There is perhaps but a single species of very wide distribution, occurring in all tropical and subtropical seas.

Alutera monoceros (Osbeck).

Balistes monoceros OSBECK, Iter Chinensis (1757) 110.

Alutera monoceros JORDAN and EVERMANN, U. S. Nat. Mus. Bull. 47, 2 (1898) 1720; JORDAN and FOWLER, Proc. U. S. Nat. Mus. 25 (1902) 274; JORDAN and EVERMANN, Bull. U. S. Fish Comm. 23¹ (1903) (1905) 423, fig. 185; JORDAN and SEALE, Bull. Bur. Fisheries 26 (1906) 36.

Aluteres berardi LESSON, Voy. Coquille, Zool. 1st part, 2 (1830) 108, pl. 7.

Alutera cinerea SCHLEGEL, Fauna Japonica 3 (1842) 292, pl. 131, fig. 1.

Aleuteres berardi RICHARDSON, Zool. Voy. Sulphur, Ichth. 132 (1845) pl. 61, fig. 1.

Aluteres monoceros BLEEKER, Atlas Ichth. 5 (1865) 140, pl. 226, fig. 2.

Monacanthus monoceros GÜNTHER, Cat. Fishes 8 (1870) 251; DAY, Fishes of India (1878) 693, pl. 179, fig. 2.

Dorsal I, 50; anal 52 in my specimen, but the rays in the soft dorsal vary from forty-five to fifty and in the anal from forty-eight to fifty-three. The oblong body strongly compressed, its depth about 2.5 times in length; head very deep, with upper and lower profiles each convex; head, measured to the lower or anterior end of gill slit 3.9 times in length, to the upper end 3.1 in length, and to base of pectoral 3.5 times in length, the last equal to the thin, narrow snout; mouth small, subterminal, chin slightly projecting; the circular eye contained 4.4 times in snout, and placed far back and high up, the distance from its upper margin to dorsal spine equal to its own diameter; gill slit half again as long as eye; its upper or posterior end beneath posterior margin of eye, between the latter and pectoral fin; the lower or anterior end of gill slit lies in front of upper part of pectoral base and forward of eye; dorsal spine rough, with four rows of very small barbs, and inserted a trifle anterior to middle of eye; it is very weak and slender and in my specimen has been broken off, leaving but a stub; soft dorsal and anal fins low, alike in shape, highest anteriorly; caudal fin convex, its length 5.75 times in head and body; skin covered with minute scales bearing excessively small spinelets, and velvety to the touch when rubbed

toward tail, but like the finest emery cloth when stroked in the opposite direction.

Color in alcohol pale brown above, the ventral half of head and trunk whitish, mottled with darker brown; tail dusky, the other fins all colorless.

This description is from a specimen having a total length of 190 millimeters, or 157 millimeters without the tail, obtained by Seale in the Manila market in 1907. The only other Philippine record is that of Jordan and Seale, who had a small specimen, also from Manila.

This circumtropical fish occurs in all warm seas, north to China and Japan in the Pacific, and to Cape Cod, Massachusetts, in the Atlantic, but is most abundant in the East and West Indies. It seems to vary greatly with age, and has accordingly been described under many names, of which I have quoted only a few. It attains a length of 610 millimeters and, according to Osbeck and Siebold, is eaten in China and Japan. Day quotes Osbeck as saying "looks like a flounder at a distance and has almost the same taste, but is not so fat."

In Manila it is said by the Tagalogs to be poisonous.

Genus OSBECKIA Jordan and Evermann

Osbeckia JORDAN and EVERMANN, Check List of Fishes, Report U. S. Fish Comm. (1895) (1896) 424.

This genus is very close to *Alutera* but differs particularly in the very long caudal fin, with much elongated middle rays and short marginal ones; head pointed, with a long snout and concave upper profile; caudal peduncle wide, twice in snout; coloration bizarre, not uniform, with irregular blue spots and lines and circular black polka dots.

There is but a single circumtropical species, which occurs in all warm seas.

Osbeckia scripta (Osbeck).

Balistes scriptus OSBECK, Iter Chinensis 1 (1757) 144.

Balistes laevis BLOCH, Ichthyol. 12 (1797) 65, pl. 414.

Osbeckia scripta JENKINS, Bull. U. S. Fish Comm. 22 (1902) 484; JORDAN and EVERMANN, Bull. U. S. Fish Comm. 23¹ (1903) (1905) 422, fig. 184; JORDAN and FOWLER, Proc. U. S. Nat. Mus. 25 (1902) 276; EVERMANN and SEALE, Bull. Bur. Fisheries 26 (1906).

Aleuteres laevis RICHARDSON, Zool. Voy. Sulphur, Ichth. (1845) 31, pl. 61, fig. 3.

- Aluteres scriptus* BLEEKER, Atlas Ichth. 5 (1865) 141, pl. 227, fig. 4.
Monacanthus scriptus GÜNTHER, Cat. Fishes 8 (1870) 252; DAY,
Fishes of India (1878) 694, pl. 176, fig. 3 (plate numbered incor-
rectly in text and labeled *Anacanthus*).
Alutera scripta JORDAN and EVERMANN, Fishes N. and M. America,
U. S. Nat. Mus. Bull. 47 (1898) 1719.

Local name: *Samarang*, Tao Sug. Filefish, foolfish, unicorn fish, English.

Dorsal I, 45-48; anal 50-51. The depth of the oblong and greatly compressed body is contained from 2.8 to more than 3.1 times in head and trunk and is nearly or quite equal to the elongated caudal fin; mouth small, oblique, with broad, fleshy lips, prominent teeth, and heavy, rounded chin jutting out beyond it; the narrow, elongated, concave snout equals length of head to base of pectoral and is contained from 3.4 to 3.75 times in length; distance from tip of snout to gill opening contained from 3.75 to 4 times in length; eye large, circular, its diameter contained from 4.3 to 5.1 times in snout, far back and very high up, the convex interorbital space wider than an eye diameter; base of pectoral below middle or anterior half of eye; upper or posterior end of the long, diagonal gill slit lies below posterior half of eye, its middle below anterior margin of eye, and the lower end in front of middle of pectoral; the unarmed dorsal spine is over middle or posterior half of eye and varies greatly in length; in one specimen it is a stubby, sharp-pointed prickle, less than half an eye diameter in length; in my largest specimen, it is 7 times as long, slender and weak, half as long as snout, while in another, rather small specimen it is 0.64 as long as snout; soft dorsal and anal fins moderately low, of similar outline, and nearly uniform in height throughout their length, the anal fin the longer; caudal fin wide and long, the median rays the longest, from 2.5 to 3.2 times in length, its width about $\frac{5}{8}$ of its length; skin covered with minute scales and almost velvety to the touch.

The color of alcoholic specimens may be chocolate brown, buff, light brown, or gray brown, with irregular blue or darker brown streaks and lines, everywhere sprinkled with rather large blackish or dark dots, the arrangement of the lines about the dots often resembling oriental or cabalistic script; caudal fin dark, with darker crossbands; the other fins colorless.

Here described from eight specimens varying in length from 82 to 260 millimeters, obtained at the following localities: Iba, Zambales; Manila; Calapan, Mindoro; San Miguel Bay, Cama-

rines; Jolo, Sulu. It has been listed previously from Jolo, by Evermann and Seale.

This circumtropical fish occurs in all warm seas, northward to Japan, Hawaii, the west coast of Mexico, and South Carolina, southward in the Pacific Ocean throughout Polynesia, in the Indian Ocean to Zanzibar, and in the Atlantic Ocean to Brazil and the Canary Islands. It reaches a length of nearly a meter but, like its congeners, is not only worthless but dangerous, as its flesh is poisonous.

Genus **PSEUDALUTERES** Bleeker

Pseudaluteres BLEEKER, Atlas Ichth. 5 (1865) 100 and 139; Ned. Tijdschr. Dierk. 3 (1866) 14.

Pseudaluteries BLEEKER, Ned. Tijdschr. Dierk. 2 (1865) 273.

This genus is especially distinguished by the position of the first dorsal, the weak slender spine being placed on the snout forward of the eye; body oblong, with belly not at all prominent; snout convex and gill openings behind eyes; in males there is a small patch of bristles on the sides of the caudal peduncle. The second spine of the first dorsal is reduced to a short blunt rudiment and the ventral is entirely wanting.

But a single small species is known of this genus, which is closely related to *Osbeckia*.

Pseudaluteres nasicornis (Schlegel).

Alutera nasicornis SCHLEGEL, Fauna Japonica, Poiss. (1846) 223, 131, fig. 2.

Pseudaluteres nasicornis BLEEKER, Atlas Ichth. 5 (1865) 139, pl. 221, fig. 1, male; pl. 224, fig. 2, female.

Dorsal II, 46-49; anal 43-46. Depth contained from 3.3 to 3.4 times, and head about 3.75 times in length; snout contained from 1.4 to 1.7 times in head; eye contained about 4 times in head and from 2 to 2.6 times in snout; the length of the slender, barbless dorsal spine may be a little greater or less than that of head and it is placed far forward of eyes; distance from spine to tip of snout contained from 2 to 2.6 times in head; snout convex, mouth small, and lower jaw projects slightly; length of gill opening smaller than diameter of eye and well behind posterior margin of eye; the free margin of caudal but little convex, the angles not rounded; second dorsal begins in advance of anal; both are low, long, and of similar outline; body entirely and uni-

formly covered with minute scales which feel velvety when stroked toward tail but like fine sandpaper when rubbed in the reverse direction.

Color in alcohol uniform pale yellowish brown, paler beneath; a dark brown stripe on each side of back, beginning at dorsal spine and extending to posterior extremity of soft dorsal; a similar stripe extends from eye to base of caudal fin; middle of caudal fin very dark brown.

Here described from three specimens having lengths of 56, 64, and 75 millimeters. The first two were collected by Alvin Seale, in 1907, and the last by students of Silliman Institute, in 1913, at Dumaguete, Oriental Negros.

Since writing the above I have received two specimens, 40 and 42 millimeters in length, from E. H. Taylor, who collected them on the southern coast of Cotabato Province, Mindanao. They are brownish along the back, merging into white on the belly, with a bright silvery luster over all; the caudal fin is black, with pale margins.

This unimportant little fish is known from Zanzibar and Mauritius to Japan.

PSILOCEPHALIDÆ

The fishes of this family have the body narrow, meager, much elongated, with strangely formed elongate head, the mouth above, and a long wide fleshy barbel on the chin; the gill openings are forward of the eyes; the first dorsal fin is reduced to a very small feeble spine placed over the hind margin of the eye; vertebræ twenty-nine or thirty.

A peculiar family containing one genus with but a single remarkable species.

Genus **PSILOCEPHALUS** Swainson

Psilocephalus SWAINSON, Nat. Hist., Fishes 2 (1839) 327.

Dorsal I, 44-52; anal 57-65. The generic characters are as above; the soft dorsal and anal are long, with many rays; the conspicuous lateral line begins behind mouth and passes backward and upward toward eye, around which it curves downward and then upward to a point opposite upper part of eye; thence it runs posteriorly parallel with back to a point about over anus, from which it descends and proceeds along the middle line of body to tail.

Psilocephalus barbatus (Gray).

Balistes barbatus GRAY, Illustr. Indian Zool. 1 (1830) Pisces, pl. 1, fig. 2.

Psilocephalus barbatus SWAINSON, Nat. Hist., Fishes 2 (1839) 327; BLEEKER, Atlas Ichth. 5 (1865) 143, pl. 226, fig. 1 (male).

Anacanthus barbatus GRAY, Zool. Misc. (1831) 8 (name preoccupied); GÜNTHER, Cat. Fishes 8 (1870) 255; DAY, Fishes of India (1878) 694, pl. 179, fig. 1 (female).

Aluterus barbatus HOLLARD, Ann. Sci. Nat. II 4 (1855) 17, pl. 1, fig. 4 (very poor figure).

Dorsal I, 49; anal 57. This extraordinary-looking fish is recognized at first glance, as it is entirely unlike any other plecognath fish. The elongated head, trunk, and tail, the peculiar mouth and protruding chin (the latter with a long barbel), and the strange position of the gill slit, all serve to emphasize its difference. The depth is contained $7\frac{2}{3}$ times in length and 11.1 in the length over all; distance from tip of snout to gill slit contained 4.6 times in length, from tip of snout to base of pectoral 3.45 times in length, from tip of snout to end of skull 3.23 times in length, while the distance from point of chin to base of skull is 2.95 times in length; head excessively elongated, its depth at base of pectoral being but $\frac{1}{3}$ of its length; the long, thin snout is a straight line to base of upper lip where it is sharply upturned, and is contained 1.28 times in head; lips thick and the small mouth is made strongly oblique or vertical by the boldly protruding chin and upturned lower jaw; from the chin hangs a long barbel, very stout at base but threadlike toward tip, its length a little more than 8 times in head and trunk; the circular eye is far back and high up, not over half its diameter below profile, and is rather small, being contained 6.25 times in snout and 8 times in head; gill slit low, strongly inclined, its upper or posterior end beneath anterior margin of eye (or wholly in advance of eye), its length a trifle less than width of eye in my specimen; base of pectoral behind eye; the slender, short, unarmed, and feeble dorsal spine inserted over posterior margin of eye; the soft dorsal and anal fins both low, anal extending farther forward and backward than does the first named; the length of the long, narrow, wedge-shaped caudal fin is contained 2.37 times in head and trunk, the middle rays more than twice the length of the outer ones; skin smooth to the touch; the scales visible only with the aid of a lens; vertebræ thirty.

The color in alcohol is uniform light brown, the head paler; barbel blackish brown; caudal fin dark, with six or more dark crossbars; the other fins all very pale yellowish.

The above description is written from a female specimen, filled with eggs, taken by L. E. Griffin at Bantayan Island in May, 1909. Its length is 207 millimeters; caudal fin, 87; chin, 6; total length over all, 300 millimeters. Male specimens have a long ventral skinny flap in the form of an elongated obtuse triangle, the base extending from near the chin to the anus.

This singular fish, not heretofore recorded from the Philippines, is abundant on the coast of Hindustan about Madras, and occurs eastward throughout the East Indies at least as far as Celebes.

Suborder OSTRACODERMI

TRUNKFISHES

Local names: *Baca-baca*, Filipino Spanish; *tikung*, Visayan.

This small group contains but a single family and includes those plectognaths in which the body is inclosed in a rigid bony box made up of six-sided plates joined by structures, so that only the jaws, fins, and tail are movable. Spinous dorsal and ventral fins are lacking, while the pectorals, soft dorsal, and anal are all small. The mouth is small, and the bones of the jaws are fused, each jaw having but a single row of long narrow teeth. There are but fourteen vertebræ, the anterior ones elongate, the last five very short; there are no ribs.

The body is short, three-, four-, or five-sided; the gill opening is an almost vertical slit below and behind the eye.

This group, a singular offshoot from the Sclerodermi, represents a development along a line of defense entirely different from that followed by any other plectognaths. The single family is composed of a few kinds of small or medium-sized fishes, usually considered to possess feeble swimming powers. They are widely distributed in all warm seas, where they live near the bottom in shallow water. They are carried great distances by ocean currents, in which they drift almost helplessly. According to Bleeker, very large specimens are quick, powerful swimmers, though probably only for short dashes.

Trunkfishes are often cooked and eaten, the fish being gutted through an incision in the belly and then baked in the shell. They are usually considered to be wholesome, but Dr. Leon M. Guerrero of the Bureau of Science informs me that the flesh of large specimens is poisonous. However, their powerful coat of mail seems to make unnecessary the development of poisonous alkaloids to the same extent as in the hornfishes, trigger fishes,

and puffers. From the time of the first tropical explorers the trunkfishes have been well known, since they are easily dried, and have been in demand in Europe and America as curiosities.

OSTRACIIDÆ

The short body is more or less cubical, and is inclosed in a shell, as previously stated, only the jaws, fin bases, and caudal peduncle being free and covered by smooth skin. One of the two genera is known from the Philippines.

Genus OSTRACION Linnæus

Ostracion LINNÆUS, Syst. Nat. ed. 10 (1758) 330.

In this genus the coat of mail is continuous behind the anal fin, and not open as in *Aracana* Gray, which as yet is not recorded from the Philippines. Spines may be present or absent on the head and abdomen; the middle of the back may be smooth, with a ridge running lengthwise, or this may be crowned by a long sharp spine; ridges are developed at the sides and the trunk may be either four- or five-angled; the dorsal rays are nine or ten, the caudal rays always ten in number.

Key to the Philippine species of *Ostracion*.

- α'. Shell five-ridged, the dorsal ridge usually topped by a long spine; spine over eye pointing up; spines on ventrolateral ridges pointing backward (subgenus *Tetrosomus*)..... *O. gibbosus*.
- α". Shell four-angled, dorsal ridge absent or very low, with or without a very small spine.
 - β'. No spine over eye (subgenus *Ostracion*).
 - ♂. No median dorsal ridge; anal behind dorsal; a large ocellus on each plate on top and sides of trunk..... *O. tuberculatus*.
 - ♂. A low median dorsal ridge; anal origin under anterior half of dorsal; each plate on back and sides with two or more small circular dark spots..... *O. rhinorhynchus*.
 - β". Spine over eye very long, pointing forward; a similar spine below tail, pointing backward (subgenus *Lactoria*)..... *O. cornutus*.

Ostracion gibbosus Linnæus.

Ostracion gibbosus LINNÆUS, Syst. Nat. ed. 10 (1758) 331; GÜNTHER, Cat. Fishes 8 (1870) 258.

Ostracion gibbosum JORDAN and SEALE, Bull. Bur. Fisheries 26 (1906) 36; EVERMANN and SEALE, Bull. Bur. Fisheries 26 (1906) 101.

Ostracion turritus BLEEKER, Atlas Ichth. 5 (1865) 30, pl. 203, fig. 3; DAY, Fishes of India (1878) 695, pl. 181, fig. 4.

Dorsal 9; anal 9; pectoral 10. In a typical specimen, 61 millimeters long, much resembling Day's figure cited above, the depth without the spine is 2.25 times, the breadth 1.5, and the head 3.2 times in the length; eye 1.75 times in snout and $2\frac{3}{8}$ in head.

A much larger specimen, 133 millimeters long, or 167 millimeters including the caudal fin, has the depth 2.5, the breadth 1.87, and the head 4 times in length; the eye is $1\frac{5}{7}$ times in snout and 2.35 in head.

Body roughly triangular, very broad, the ventrolateral ridges expanded, each with four stout, sharp, curved, backward-directed spines, the posterior largest; a small erect spine over each eye, with a ridge running backward toward tail and disappearing beneath and posterior to dorsal; a large broad longitudinal ridge along middle of back, merely roughened in our large specimen, but usually culminating in a very large compressed spine, as in our small example; snout blunt, concave, interorbital space deeply concave; eyes large, nearly circular; dorsal fin immediately behind dorsal ridge and well in advance of anal; gill opening short, below or behind posterior margin of eye; nine plates from gill opening to caudal peduncle; eight plates from middorsal ridge to ventrolateral ridge and eleven plates across widest part of ventral surface.

Color in alcohol brownish yellow, paler yellow beneath, the fins yellow or paler; three or four ill-defined dark brown spots or bars on lower third of body and a similar spot on dorsal spine; base of dorsal, anal, and caudal each with an obscure dark spot. Jordan and Seale⁴ state that their specimens were "yellowish white, with about 4 dusky oblique bars on side."

The Bureau of Science specimens above described were collected at Bantayan Island, off the northwest coast of Cebu. The collection also contains a specimen, 20 millimeters long, obtained at Balayan Bay, Batangas.

In the University of Santo Tomas Museum are specimens from Manila Bay and Mindoro; in the Ateneo de Manila Museum is a very fine specimen from Davao, Mindanao, and one from Cebu.

This species has been recorded previously from Cavite on Manila Bay and from Jolo. It occurs from Aden and Zanzibar to Celebes and Amboina.

⁴ Loc. cit.

Ostracion tuberculatus Linnaeus.

Ostracion tuberculatus LINNÆUS, Syst. Nat. ed. 10 (1758) 331.

Ostracion tuberculatum JORDAN and SEALE, Bull. Bur. Fisheries 26 (1906) 36; EVERMANN and SEALE, Bull. Bur. Fisheries 26 (1906) 101.

Ostracion argus RÜPPELL, Fische des Rothen Meers (1828) 4, pl. 1, fig. 1.

Ostracion cyanurus RÜPPELL, Fische des Rothen Meers (1828) 4, pl. 1, fig. 2.

Ostracion immaculatus SCHLEGEL, Fauna Japonica, Poiss. (1846) 296.

Ostracion immaculatum JORDAN and FOWLER, Proc. U. S. Nat. Mus. 25 (1902) 280.

Ostracion tetragonus BLEEKER, Atlas Ichth. 5 (1865) 39, pl. 201, fig. 2, and pl. 203, fig. 2.

Ostracion cubicus GÜNTHER, Cat. Fishes 8 (1870) 260; Fische der Südsee 3 (1910) 453; DAY, Fishes of India (1878) 696, pl. 181, fig. 3.

Local name: *Tabayong*, Visayan.

Dorsal 10; pectoral 10; anal 10. A typical specimen, 330 millimeters long, has the depth 2.87 times, the width across top 3.75, across bottom 3.47, and the head a trifle more than 6 times in length; snout contained 1.14 times in head; eye 3.1 in head, 2.7 times in snout, and 1.5 times in gill slit.

In another specimen, 130 millimeters long, the depth is 2.5, the top width 3.17 and the bottom width 2.6 times, and the head about 3.9 times in length; snout 1.32 times in head, eye 2.44 times, and 1.9 times in snout; length of gill slit less than diameter of eye.

The spineless, somewhat elongate body is roughly rectangular with four blunt ridges, more prominent posteriorly than at forward end; in small specimens the greatest width nearly or quite equals depth; back more or less elevated along its middle, but there is no ridge except in some examples which have an ill-defined one before dorsal; snout boldly convex in all except small specimens, in which it is pronouncedly concave; there is a hump just above upper lip in all my examples, broad and very marked in large specimens; interorbital space concave; nine plates from gill slit to caudal peduncle, five plates across back, five or six across side, and seven or eight across widest part of underside; anal immediately behind dorsal; caudal peduncle moderately long and strong, its depth 2 or 2.5 times in head, caudal fin a little more than 0.25 of the rest of the animal; gill slit lies entirely behind eye or the anterior end may be below posterior margin of eye.

Color in alcohol brownish or brownish yellow, with a large ocellus on each back and side plate; the ocelli may appear as pale silver spots or more commonly as large dark brown spots with a pale center; more rarely they occur on the belly; head, including the skin around eyeball, underparts, and lower portion of sides more or less sprinkled with small dark brown spots; in young specimens these may also occur on back and caudal peduncle; caudal fin spotted or pale, the other fins all pale; the muscular base of dorsal has three rows of small circular dark spots on each side, or they may disappear in the preservative; the very young have large dark spots scattered over the whole surface.

In life the color is yellow or olive brown, usually with a blue, dark-edged ocellus on each dorsal and lateral scute, and with other spots as already stated.

I have examined seven Philippine specimens varying in length from 98 to 330 millimeters, obtained at Puerto Galera, Mindoro; Simara Island; Cabalian, Leyte; Zamboanga, Mindanao; and Samal Island, in Davao Gulf. I have also examined two specimens from Guam, 32 and 51 millimeters long, respectively. Specimens have been collected previously in the Philippines at Cavite on Manila Bay, Luzon, and at Jolo, Sulu Province. My largest specimen has a total length, including the caudal fin, of a little more than 400 millimeters.

This trunkfish occurs from the Red Sea and Mozambique, on the east coast of Africa, eastward throughout the East Indies, north to Japan and Marcus Island, and south to the Fiji and Samoan Islands.

In their discussion of Japanese trunkfishes Jordan and Fowler⁵ state concerning *Ostracion immaculatum* Schlegel—

* * * It is probably a subspecies of *Ostracion tuberculatum* as Bleeker has indicated, or even it may be the same species with it, as Günther regards it. We give it provisional rank as a distinct species because all our specimens are deeper in body than *O. tuberculatum*.

According to my specimens and measurements this difference will not hold, but there is a difference in the number of plates in the armor, Bleeker's and Day's figures agreeing with mine while Jordan and Fowler's count is more. Until I can compare a series of Japanese and East Indian specimens, I must agree with Bleeker that the Japanese form is not worthy of more than subspecific rank.

⁵ Loc. cit.

Ostracion rhinorhynchus Bleeker.

Ostracion rhinorhynchus BLEEKER, Verh. Bat. Gen. 24 (1852) 34, pl. 6, fig. 12; Atlas Ichth. 5 (1865) 37, pl. 201, fig. 1, and pl. 203, fig. 1; GÜNTHER, Cat. Fishes 8 (1870) 263.

Dorsal 9; anal 9; pectoral 10. Depth equals width across top and is 2.63 times in length; width across bottom $\frac{1}{6}$ greater or 2.2 times, and head 3.16 times in length; snout 1.47 times in head, eye 2.5 times, and 1.7 in snout; gill slit 2.5 times in eye; nine plates between gill slit and caudal peduncle, five across back, six in a transverse row on side, and nine across bottom; caudal peduncle thin, narrow, its depth 3.57 in head, caudal fin small, 4.15 times in length.

Body deep, four-sided, somewhat ovate, without spines, with concave sides, and strongly produced lateral ridges; a low ridge along middle of back; interorbital space slightly concave, snout convex; the small diagonal gill slit just behind eye; anal larger than, its origin forward of middle of, dorsal.

Color in alcohol gray brown, sprinkled everywhere except on ventral surface with small circular dark spots, one to five on each plate in my specimen; similar spots on the circumference of eyeball, the muscular base of pectoral, caudal peduncle, and tail fin; other fins pale.

Here described from a specimen 79 millimeters long, or 98 millimeters long over all, collected at Estancia, Iloilo Province, Panay, by H. R. Montalban.

This well-marked species has from two to ten spots on the plates and reaches a length of nearly 350 millimeters. With age the convexity on the snout becomes a large conical hump projecting forward. It has been recorded from Pinang, Java, Billiton, Celebes, Solor, Ceram, and the northwest coast of Australia.

In the University of Santo Tomas Museum are two specimens from Manila Bay, the largest 330 millimeters long over all, and one each from Cebu and Jolo.

Ostracion cornutus Linnæus.

Ostracion cornutus LINNÆUS, Syst. Nat. ed. 10 (1758) 331; SCHLEGEL, Fauna Japonica, Poiss. (1846) 299, pl. 131, fig. 4; GÜNTHER, Cat. Fishes 8 (1870) 265; DAY, Fishes of India (1878) 697, pl. 176, fig. 4; GÜNTHER, Fische der Südsee 3 (1910) 457, pl. 171 and 10 text figures.

Ostracion arcus BLEEKER, Atlas Ichth. 5 (1865) pl. 202, fig. 3, and pl. 204, fig. 4.

Ostracion cornutum JORDAN and FOWLER, Proc. U. S. Nat. Mus. 25 (1902) 282; JORDAN and SEALE, Bull. Bur. Fisheries 25 (1906) 36; EVERMANN and SEALE, Bull. Bur. Fisheries 25 (1906) 101.

Local names: *Baca-baca*, Filipino Spanish; *pega-pega*, Tao Sug. Cowfish, cuckold, English; *vaca*, Spanish.

Dorsal 9; anal 8 or 9; pectoral 10. Depth $2\frac{1}{3}$ to 2.8 times, head 2.86 to $3\frac{2}{3}$ times in length; greatest width across top from 3.5 to 4.1 in length and $1\frac{1}{2}$ times in greatest width of ventral side, which is 2.1 to 2.64 in length; snout approximately equals greatest width of upper surface of body and is 1.1 to 1.2 in head; eye 2.1 to 2.35 in head and 1.76 to 2.14 in snout; depth of caudal peduncle usually equals eye but may be only 0.65 of its diameter.

Body irregularly rectangular with slightly convex belly, and dorsolateral and ventrolateral ridges not strongly marked; there is a low, narrow, often poorly defined median ridge along dorsal surface; a pair of very long, sharp, forward-pointing, and more or less divergent spines project from the large supra-orbital ridges, and a pair of similar backward-pointing spines at posterior extremity of the ventrolateral ridges; a blunt, outwardly directed median spine on each dorsolateral ridge and a similar but much smaller spine between them on the median dorsal ridge; head very deep, its nearly vertical profile slightly undulate and slightly concave, mouth very low, pointing downward; interorbital space deeply concave; gill slit much less than an eye diameter in length and far behind eye; anal fin far behind dorsal; caudal fin very long, half or more than half the length of head and trunk together.

Color in alcohol usually brownish, belly paler, without markings; other specimens gray, grayish brown, or yellowish, one grass green; caudal and sometimes caudal peduncle with large dark spots; in most specimens there are at least traces of a broad dark interorbital band, continued over snout and between mouth and pectoral; a dark blotch below pectoral; a dark band across widest part of back and continued on sides to ventral margin; a similar band from base of posterior ventral spine up over side and across back at dorsal, connecting on middle of side and on dorsal surface with the other cross-band. The blue or dark spots described by authors are absent

in all specimens except a dried one, which had a blue spot in the center of each plate except those of the underside.

The color of four living specimens in the Bureau of Science Aquarium is very pale greenish yellow, clouded with dark bands as described for alcoholic material; a bluish or whitish pearly spot on each scale except on belly, which is clear yellow; lips yellowish with a broad blackish line behind them; fin rays very pale, the membranes transparent.

Except when actively swimming about, this preposterously solemn and dignified-looking fish keeps the caudal fin folded, slowly moving about by the incessant and rapid movements of the other fins. The greatly elongated tail fin is a powerful sculling oar when expanded to its full width, which is apparently disproportionate for the rest of the fish.

This fantastic and variable fish is readily recognizable by its horns, which rarely are bifid or crooked; in young specimens the ridges are more pronounced, but in adults they are almost smooth; the caudal becomes proportionately very much larger in old specimens, until eventually it may be nearly as long as the coat of armor; at the same time the "horns" are blunt and proportionately much shorter than in the young. In a specimen from Zamboanga with a length of but 23 millimeters the tail is very short, not extending to the end of the short posterior spine, while the orbital spines are also but little developed; however, in specimens but little larger the anterior and posterior spines become greatly elongated, the latter extending beyond the tip of the caudal fin until the fish attains a length of about 50 millimeters.

I have examined very many specimens, both living and preserved, of this common coral-reef inhabitant, from Puerto Galera and Calapan, Mindoro; Cuyo; Puerto Princesa, Palawan; Zamboanga and Davao, Mindanao; and Jolo. These range in length from 23 to 138 millimeters, the largest being 220 millimeters long with the caudal fin. It has been previously recorded from Cavite on Manila Bay and from the southern coast of Negros, by Jordan and Seale, and is a common curio in all public and private collections and as an ornament in the home.

This species occurs from the Red Sea and Zanzibar to Japan, Marcus Island, and Tahiti. I have a specimen, about 35 millimeters long over all, which was obtained many years ago from the stomach of a dolphin, *Coryphæna* species, caught in the mid-Pacific.

Suborder GYMNOTONTES

The plectognaths belonging to this suborder are degraded forms which have lost their scales, spinous dorsal, and separate teeth. In the most-specialized forms the ribs, pelvis, and caudal vertebræ are also lost, so that they present a very singular appearance. The Gymnodontes are so named because the jaws are enveloped in an enamel-like covering, without distinct teeth, which forms a powerful parrotlike beak; the body is short to very short and in all but the Molidae the belly is more or less inflatable. The scales typically resemble spines or bristles and have rootlike insertions. In this group the development of poisonous alkaloids in the flesh reaches its maximum; other means of defense, well developed in this group of poor swimmers, are the spines and bristles, the power of inflation, and the tough and leathery skin.

Key to the families of Gymnodontes.

- a¹. Caudal fin normally developed, with a distinct caudal peduncle.
 - b¹. Upper and lower jaws each divided into right and left halves.
 - c¹. Back broadly rounded; head broad; nostrils various; frontal bones united with supraoccipital..... Tetraodontidæ.
 - c². Back more or less sharply ridged; nostrils obsolete or very small; frontal bones separated from supraoccipital by the postfrontals, which meet in the middle..... Canthigasteridæ.
 - b². Upper and lower jaws each entire; premaxillary and dentary bones grown together, forming jointless arches; maxillaries extended laterally behind; body covered with stout rooted spines.. Diodontidæ.
- a². Body truncated behind dorsal and anal, without caudal peduncle and with the caudal region aborted; jaws without division..... Molidae.

TETRAODONTIDÆ

GLOBEFISHES, PUFFERS, OR SWELLFISHES

Local names: *Botiti* or *botete*, most Filipino languages; *tikung* or *langiguihon*, Visayan; *tinga-tinga*, Tao Sug.

This dangerous group of fishes is widely distributed in warm seas all over the world and is common throughout the Philippines. Although most people are more or less aware of the poisonous properties of the flesh, it is eaten in practically every Philippine fishing village and not a year goes by without several deaths from this cause. A Japanese investigator⁶ has

⁶I have been unable to obtain a copy of his paper, which appeared in the Archiv für Pathologie und Pharmacologie.

studied carefully the alkaloid present in the flesh of the Tetraodontidæ and finds it to be very near muscarine, the active poisonous principle of *Amanita muscaria* and other fungi. It is a tasteless, odorless, and very poisonous crystalline alkaloid. The dangerous alkaloid seems to be most abundant and virulent in the eggs or roe and sperm or milt; it is claimed by the fishermen that the gall bladder is also very poisonous. Many Filipinos believe that if the entrails and skin are removed from *botiti* the flesh is wholesome. While this may be more or less true, especially when the breeding season is not near, it is nevertheless very dangerous to eat the flesh of *botiti*, and their sale and use should be forbidden.

The body is oblong to elongate, usually but slightly compressed, and may be very broad, especially the head and snout; the belly is capable of great inflation, the animal swallowing air when disturbed or frightened, and then floating on the surface belly up, a trait which gives the fish its common name. The fishes of some species are able to swell up so much that they become helpless globes with beak and tail attached at opposite poles. The skin is scaleless, more or less prickly or bristly, the spines or prickles usually weak and movable; rarely the skin is armed with bony scutes, forming a sort of carapace. Many authors have laid much stress upon the bristles and spines, their length and presence or absence, while the presence of a coat of long furlike bristles in some specimens and the almost total absence of bristles in others of the same species has been puzzling to many. The reason for this variation is merely that these fishes have the power of extruding and withdrawing their defensive bristles at will.

The lips are full and the jaws form a broad prominent bony beak, each half divided by a median suture; the maxillaries are curved outward behind the premaxillaries. The spinous dorsal is lacking, the fins being composed of soft rays only; the dorsal fin is posterior, opposite and similar to the anal; the caudal fin is distinct and well developed; the pelvic bones are undeveloped, the ventral fins therefore absent; there are no ribs; the pectoral fins are short and broad, their upper rays longest; the gill openings are small, in front of and close to the pectorals; an air bladder is present; the vertebræ are few in number, 7 or 8+9 to 13.

Key to the Philippine genera of Tetraodontidæ.

- a*¹. Nostril on each side with two distinct openings, usually in a low tube or papilla *Spheroides*.
- a*². Nostrils without openings.
 - b*¹. Nostril a simple unperforated cavity with two marginal flaps or fringed margin..... *Chelonodon*.
 - b*². Nostril on each side a bifid tentacle without opening..... *Tetraodon*.

Genus *SPHEROIDES* Lacépède

The oblong or elongate body is covered more or less by prickles or bristles; there is a single short simple nasal tube on each side, with two distinct or rather large openings near its tip, or the tube may be reduced to a mere rim; the frontal bones are expanded laterally and from the lateral roof of the orbit, the postfrontals limited to the posterior portions; the abdomen is capable of very great distension; in some species there is a distinct fold of skin along the lateroventral portion of the body, especially on the posterior region; vertebræ eighteen to twenty-one.

The genus is a large one, chiefly tropical, and some of the species reach a comparatively large size. In this genus I include *Lagocephalus* of authors, with elongate body, silvery skin, and prominent lateral fold, as well as the typical *Spheroides* with the shape of *Tetraodon*, since there are transitional forms covering every gradation from one extreme to the other. Some of the species are exceedingly poisonous.

Key to the Philippine species of Spheroides.

- a*¹. No black, white-margined spots or bands on back.
 - b*¹. Color above pale brown, thickly sprinkled with small circular dark spots *S. sceleratus*.
 - b*². Back not covered with circular dark spots.
 - c*¹. Back uniform brown to pale gray..... *S. lunaris*.
 - c*². Back not uniform but variously banded and spotted.
 - d*¹. Back brown, with many white or light irregular spots; sides with transverse brown bands and light bars alternating.
 - S. oblongus*.
 - d*². Back dark brown, extending to middle of sides as a sharply defined blanket, with white or milky spots and many fine white lines and specks; three or four dark brown crossbars on cheeks.
 - S. hypselogeneion*.
 - a*². A large, black spot behind each pectoral, connected by a black band, the whole surrounded by a white margin; a black, white-edged spot at base of dorsal..... *S. ocellatus*.

Spheroides scleratus (Forster).

Tetraodon scleratus (Forster) GMELIN, Syst. Nat. (1788) 1444.

Spheroides scleratus JORDAN and SNYDER, Proc. U. S. Nat. Mus. 24 (1901) 234.

Tetrodon scleratus GÜNTHER, Cat. Fishes 8 (1870) 276; Fische der Südsee 3 (1910) 461.

Tetrodon argenteus LACÉPÈDE, Ann. Mus. Hist. Nat. (1804) 211, pl. 58, fig. 2; SCHLEGEL, Fauna Japonica, Poiss. (1847) 275, pl. 121, fig. 2; BLEEKER, Atlas Ichth. 5 (1865) 64, pl. 209, fig. 1.

Dorsal 12; anal 11. Depth contained 5 times, head 2.88 times in length; eyes very large, elongate, 3 times in head, 1.4 times in snout, and 1.17 times in the flat interorbital space; snout 2.16 times, interorbital 2.6 times in head; caudal peduncle elongate, very low, its least depth 10.4 times in head; caudal fin contained 6 times in head and trunk.

Body elongate, slender, with long and roughly rectangular, laterally compressed head and depressed tail; the whole body, except lips, tail, and a strip along the side from pectoral backward, covered with prickles.

Color in alcohol pale brown above, thickly sprinkled with small dark brown circular dots and spots; a silvery band along sides and below it a narrow brownish band running around chin, the underparts white; a triangular silvery spot in front of each eye; gill openings blackish.

Here described from a specimen 150 millimeters long, collected at Basilan. This species was obtained in the Philippines by the celebrated English collector Hugh Cuming; it is well known to the Moros, and several deaths from eating it have been reported from time to time, especially about Basilan. It is apparently rare elsewhere in the Philippines.

This dangerous fish occurs from Zanzibar and Cape Guardafui eastward to Australia and Tahiti and northward along the Asiatic coast to southern Japan. It attains a length of approximately 700 millimeters.

Spheroides lunaris (Bloch and Schneider). Plate 2, fig. 4.

Tetrodon lunaris BLOCH and SCHNEIDER, Syst. Ichth. (1801) 505; SCHLEGEL, Fauna Japonica, Poiss. (1847) 277, pl. 122, fig. 1; GÜNTHER, Cat. Fishes 8 (1870) 274; DAY, Fishes of India (1878) 701, pl. 182, fig. 2.

Tetraodon lunaris BLEEKER, Atlas Ichth. 5 (1865) 63, pl. 205, fig. 2.

Spheroides lunaris JORDAN and SEALE, Proc. U. S. Nat. Mus. 28 (1905) 790; Bull. Bur. Fisheries 26 (1906) 36; EVERMANN and SEALE, Bull. Bur. Fisheries 26 (1906) 101; SEALE and BEAN, Proc. U. S. Nat. Mus. 33 (1907) 248; JORDAN and RICHARDSON, Bull. Bur. Fisheries 27 (1907) 1908.

Tetrodon spadiceus RICHARDSON, Zool. Voy. Sulphur, Ichthyology (1845) 123, pl. 58, figs. 4 and 5; BLEEKER, Atlas Ichth. 5 (1865) 64, pl. 207, fig. 1; JORDAN and SNYDER, Proc. U. S. Nat. Mus. 24 (1901) 234.

Local name: *Botiting sagwing*, Tao Sug.

Dorsal 12; anal 11–12. Head contained 2.6 to 3 times, caudal fin 2.9 to 4.4 times in length; snout from 1.94 to 2.2 times in head; eye 2.8 to 4 times in head, 1.2 to 1.9 in snout, and equal to or 1.7 times in interorbital, the last named 2.1 to 2.9 times; caudal peduncle from 4.1 to 6.1 times in head; normal depth equal to or less than length of head.

Body elongate, oblong, head and trunk strongly flattened along sides, caudal peduncle long, low, more or less cylindrical; snout convex, blunt, interorbital space slightly concave or flat; back low, slightly convex or little elevated, rather flattened, but with a keel before dorsal fin; eyes very large, placed very high up; upper teeth prominent, projecting over lower; small, somewhat closely set spines on back, extending from the region behind nostrils to dorsal; a patch of similar but coarser and more widely spaced spines on belly, from a point below nostrils nearly to anus; rest of body spineless; a distinct ridge or fold of skin beginning on chin and extending back along the side above belly to base of caudal fin, which is lunate; belly may be very greatly distended, the depth then 1.5 times the length of head.

The color in alcohol varies from uniform brown above to pale mouse gray on back; a broad silvery white band on sides from snout to tail; underparts white or yellowish; the fins are all pale or the posterior part of caudal may be dark; iris yellow.

Here described from very many specimens, varying in length from 30 to 240 millimeters, from the following localities: Alaminos, Pangasinan; Manila and Cavite, Manila Bay; Balayan Bay, Batangas; Guinyangan, Bondoc Peninsula, Tayabas; and San Miguel Bay, Camarines, all in Luzon; Estancia and Barotac Nuevo, Panay; Cebu, Cebu; Cagayan de Misamis, Mindanao; Amoy and Hongkong, China; and Sandakan, Borneo. Some of these are typical *lunaris*, others the *spadiceus* of Bleeker, but there are all stages of intergrading forms between, so that I am compelled to unite them. The best distinguishing character is the lateral line in its course beneath the eye, but specimens of the same lot often show great variation in this respect, so that it, too, is valueless. Previously this fish has been noted

in the Philippines from San Fabian, Pangasinan Province, Luzon; Iloilo, Panay; Oriental Negros; and Zamboanga, Mindanao.

This species attains a length of more than 300 millimeters, and is very abundant throughout the East Indies, from whence it ranges westward to the coasts of Hindustan and the Red Sea and northward to Japan.

Spheroides oblongus (Bloch).

Tetrodon oblongus BLOCH, Ichthyologie 5 (1787) 4, pl. 146, fig. 1; BLEEKER, Atlas Ichth. 5 (1865) 62, pl. 208, fig. 4; GÜNTHER, Cat. Fishes 8 (1870) 278; DAY, Fishes of India (1878) 702, pl. 182, fig. 3.

Spheroides ocellatus JORDAN and SEALE, Proc. U. S. Nat. Mus. 28 (1905) 791 (not of Osbeck); Bull. Bur. Fisheries 26 (1906) 36 (not of Osbeck).

Dorsal 13; anal 11. Depth uninflated equals length of caudal fin or 2.7 to 3.5 times in head and trunk; head contained 2 to 2.64 times in length; eye of moderate size, 4 to 4.85 times in head; 1.7 to 2.25 times in snout, and 2.25 to 2.5 times in interorbital space, and equal to, or two-thirds of, depth of caudal peduncle; snout 2.5 to $2\frac{1}{3}$ times, interorbital space 1.75 to almost twice in head.

Body stout, oblong, wedge-shaped, with compressed sides, a short, bluntly triangular, slightly convex to slightly concave snout, a flat or concave interorbital space, slightly arched or nearly flat back, and a very distensible belly; upper and lower teeth about equal in size; caudal fin truncate, rather small; very small and mostly widely spaced spines present everywhere except on lips, snout in front of nostrils, and that part of body lying posterior to origin of dorsal.

Color in alcohol brown above, with many white or pale irregular spots, the brown descending on sides in irregular transverse bands with white bars ascending between them posteriorly; the band behind pectorals and the one including base of dorsal very broad and much darker than the rest; a silvery yellowish band on sides and continuous around chin, belly white; tip of caudal blackish, the rest of the fins pale or yellowish.

Here described from two specimens, one 74 millimeters long, from Masbate; the other 78 millimeters long, from Panacan, Palawan. I have also examined a specimen sent for determination from Amoy, China, collected by S. F. Light.

This very handsome botiti runs into several well-marked varieties, some of which may be true species, but my few speci-

mens are quite typical. This species reaches a length of nearly 400 millimeters and occurs along the southern coasts of Asia from India to Amoy, and northeastward through the Sunda Islands to the Philippines. According to Seale, it occurs at Faté, one of the New Hebrides group.

Spheroides hypselogeneion (Bleeker).

Tetrodon hypselogeneion BLEEKER, Nat. Tijdschr. Ned. Ind. 3 (1852) 300; Atlas Ichth. 5 (1865) 61, pl. 213, fig. 5.

Spheroides hypselogeneion JORDAN and SEALE, Bull. Bur. Fisheries 25 (1905) 368; EVERMANN and SEALE, Bull. Bur. Fisheries 26 (1906) 100.

Tetrodon hypselogeneion GÜNTHER, Cat. Fishes 8 (1870) 277, in part; DAY, Fishes of India (1878) 702, pl. 183, fig. 5; GÜNTHER, Fische der Südsee 3 (1910) 462, pl. 172, fig. A.

Dorsal 8; anal 7 or 8. Head 2.5 or 2.6 times, caudal 3.2 to 3.4 times in length; snout 2 to 2.5 times in head; eye equals or slightly exceeds interorbital space, $3\frac{3}{8}$ to $3\frac{3}{4}$ times in head; depth of caudal peduncle 4 to 5 times in head.

Body oblong, wedge-shaped, somewhat elongate, its greatest depth at gill openings, sides compressed, head and snout pointed; upper profile straight, interorbital space convex, back nearly flat; upper teeth nearly as large as lower; short, stout, coarse, widely spaced prickles cover entire body except lips and tail behind dorsal fin and anus; chin heavy, broad, angular; caudal truncate; belly moderately distensible.

Color in alcohol dark brown on back and extending as a sharply defined blanket to middle of sides, sprinkled with irregular white or milky spots and very many fine white lines and specks; a silvery white band along sides, the parts below all yellowish or whitish posteriorly; three or four dark brown crossbars on side of head, one on snout, one before and below eye, one just behind eye, and one before gill opening; the fins are all pale.

Here described from five specimens from Panacan, Palawan, and two from Davao, Mindanao. They are all small, ranging from 26 to 52 millimeters in length. Since this was in type I have received four specimens, 30 to 46 millimeters in length, from Odiongan, Tablas. The only previous Philippine record of this handsome little puffer is from Bulan, Sorsogon Province, Luzon. It occurs from the Red Sea and Zanzibar to the Fiji, Samoan, and Navigator Islands, and attains a length of about 200 millimeters.

Spheroides ocellatus (Osbeck).

Diodon ocellatus OSBECK, Iter Chinensis (1757) 226, or Eng. trans. 1 (1771) 364, 2, 331.

Tetrodon ocellatus LINNÆUS, Syst. Nat. ed. 12, 1 (1766) 411; BLOCH, Ichthyologie 5 (1787) 1, pl. 145; RICHARDSON, Zool. Voyage Sulphur, Ichthyology (1845) 120, pl. 58, figs. 1, 2, 3; GÜNTHER, Cat. Fishes 8 (1870) 279.

Spheroides ocellatus JORDAN and SNYDER, Proc. U. S. Nat. Mus. 24 (1901) 243.

Dorsal 14; anal 12. Head equals depth, 3 times in length; body rather robust, back covered with minute spines from near nostrils to dorsal fin; abdomen entirely covered with somewhat coarser spines, the rest of the fish smooth and naked; lateral ridge obscure; caudal truncate.

In alcohol the color above is olivaceous, with silvery sides, and pale underparts; there is a large black spot behind each pectoral, the two connected by a black band over back, the band and spots surrounded by a white margin; a black, white-edged circular spot or blotch at base of dorsal.

I have not seen this species, and the description above is altered from that given by Jordan and Snyder. *Spheroides ocellatus* is abundant about Canton and ranges north to Japan. It has been reported by Jordan and Seale from Manila and from southern Negros. Osbeck found it in Canton River and, according to Bloch and Schneider, it inhabits fresh water in the vicinity of the sea.

Since the above was in type I have found a specimen in a miscellaneous lot of fishes, collected by students of the University of the Philippines, of which the exact locality is unknown. This specimen, which is a duplicate of Richardson's figure 3 cited above, is 57 millimeters long; the head is 21 millimeters long, the depth 15 millimeters. There are thirteen rays in the dorsal and eleven in the anal.

Genus *CHELONODON* Müller

Chelonodon MÜLLER, Abhandl. Akad. Wiss. Berlin (1839) 252.

This genus is distinguished from other Tetraodontidæ by the nostrils, which are simple unperforated cavities surrounded by a very short membranous tube which is extended into two or more flaps or a fringelike margin. Two species are known, confined to southern and southeastern Asia and the East Indies.

Chelonodon patoca (Buchanan-Hamilton).

Tetrodon patoca BUCHANAN-HAMILTON, Acct. Fishes River Ganges (1822) 7 and 363, pl. 18, fig. 2; GÜNTHER, Cat. Fishes 8 (1870) 288; Shore Fishes Challenger, Zoölogy 1^o (1880) 54; DAY, Fishes of India (1878) 703, pl. 182, fig. 4.

Chelonodon patoca SMITH and SEALE, Proc. Biol. Soc. Washington 19 (1906) 79; SEALE and BEAN, Proc. U. S. Nat. Mus. 33 (1907) 248; JORDAN and RICHARDSON, Bull. Bur. Fisheries 27 (1907) 274.

Leiodon patoca BLEEKER, Atlas Ichth. 5 (1865) 76, pl. 210, fig. 2.

Dorsal 9-10; anal 8, 9. Head contained 2.4 to 2.6 times, depth 2.75 to 3.35 in length; eye about 4.3 to 4.85 (2.8 in young), snout 2 to 2.25, interorbital space 1.8 to 2, and caudal peduncle 2.8 to 3.25 in head.

Body stout, wedgelike, somewhat cylindrical or rectangular anteriorly and laterally, compressed posteriorly, with large obtuse head, blunt convex snout, and very broad interorbital space; eyes large, prominent; nasal opening a shallow pit with a bilobed or somewhat fringed margin; upper jaw prominent, projecting beyond lower; back covered with small spines, from behind interorbital space to dorsal fin; similar spines on belly and up on sides to base of pectorals; belly can be greatly distended; tip of caudal rounded.

In alcohol the back is brownish to very dark or blackish brown, with numerous round or oval whitish spots which extend well down upon sides; sides more or less silvery, the underparts white; a dark band across interorbital space; three dark bands across dorsal surface and descending upon sides, one behind pectorals, one including base of dorsal, and one on caudal peduncle; fins all clear except outer portion of caudal, which is dark.

I have examined very many alcoholic specimens from the following localities: Abra River, Ilocos Sur; Agno River, Pangasinan; Manila; Cavite; San Miguel Bay, Camarines Sur, all on Luzon; Calapan, Mangarin, and Pinamalayan, Mindoro; Estancia, Panay; Guinobatan, Masbate; Borongan, Samar; Cabaian, Leyte; Agusan River, Cagayan de Misamis, Davao, Placer, and Zamboanga, Mindanao; Balabac. The specimens referred to above are all small, ranging in length from 21 to 90 millimeters. Another specimen from Tacligan, Mindoro, 153 millimeters long, lacks the many small round whitish spots on sides and back, but has large white areas on the sides between the dark crossbands.

Four living specimens from Calapan, Mindoro, are yellowish or greenish olive with five very dark crossbands, the first across the interorbital space and extending below the eye as a divided band, one part diagonally forward, the other downward; the second is wide and lies behind the gills; the third is faint, midway on the back; the fourth includes the dorsal base and descends on side nearly to belly; the fifth is on the caudal peduncle; a silvery longitudinal band extends from side of head along body below pectoral to caudal; below this is a yellow strip; scattered over the back and especially on caudal peduncle are circular white spots.

This common fish, which attains a length of about 330 millimeters, occurs in shallow water along the coasts everywhere and enters rivers as far as the tides affect them. It is subject to a considerable amount of variation in color, but there is always at least a trace of the characteristic spots on the back or the posterior portion of the sides; the spots are said to be sometimes yellow. It occurs from Hindustan, where it was originally described from the Ganges, to China and eastward in the East Indies to Amboina, Ceram, Batjan, and Ké.

Genus TETRAODON Linnæus

The robust body is covered with more or less prickly or bristly skin; each nostril is provided with a tentacle which is divided into two lobes to its base, their tips without openings, the branches of the large olfactory nerve ending in cuplike depressions along the inner edges of the two somewhat flattened lobes; the eye is surrounded by a ring muscle which forms eyelids; vertebræ usually $8 + 10 = 18$.

The members of this genus are very dangerous when eaten. Because they are often abundant and easily caught there are always some who will run the risk of eating them. The medical Journal of Australia, under date of December 1, 1923, tells of two Malays who ate a species of *Tetraodon*, although warned of the danger. They ate at noon with no serious effects but on eating some for supper they were taken violently ill, one dying in an hour, the other about three hours later.

Key to the Philippine species of *Tetraodon*.

- α'. Upper and lower margins of caudal always black; no spots on body, which may be uniform olive or brown above, or with longitudinal parallel lines over whole body or on back..... *T. immaculatus*.

α^2 . Margins of caudal not black; body always spotted.

b^1 . Spots white.

c^1 . No large irregular black spots on sides.

d^1 . Back dark with small white spots or lines; curved or longitudinal lines on sides and belly; white lines curving upward around gill openings; caudal spotted to its tip.... *T. reticularis*.

d^2 . Large circular white spots on upper half of body and anterior part of caudal; belly uniform white or with narrow stripes.

T. hispidus.

c^2 . Several large irregular black spots on sides below pectorals; upper half with long wavy irregular dark brown lines inclosing circular white spots; lines on side of head vertical or radiating from eye..... *T. mappa*.

b^2 . Spots dark.

e^1 . Anus in a black spot.

f^1 . Spines black; dorsal region covered with circular spots or else pure black; caudal black spotted..... *T. aerostaticus*.

f^2 . Spines white; body with a few large irregular black spots, especially on belly; caudal not spotted..... *T. nigropunctatus*.

e^2 . Anus not in a black spot; upper part of body with many large dark brown circular spots..... *T. fluviatilis*.

Tetraodon immaculatus Bloch and Schneider.

Tetraodon immaculatus BLOCH and SCHNEIDER, Syst. Ichth. (1801) 507; JORDAN and SEALE, Proc. U. S. Nat. Mus. 28 (1905) 790; Bull. Bur. Fisheries 26 (1906) 37; EVERMANN and SEALE, Proc. U. S. Nat. Mus. 31 (1907) 510; SEALE and BEAN, Proc. U. S. Nat. Mus. 33 (1908) 248; JORDAN and RICHARDSON, Bull. Bur. Fisheries 27 (1907) 273; WEBER, Fische der Siboga Exp. (1913) 584.

Tetrodon immaculatus GÜNTHER, Cat. Fishes 8 (1870) 291; DAY, Fishes of India (1878) 703, pl. 183, fig. 4; GÜNTHER, Shore Fishes Challenger, Zoölogy 1.⁶ (1880) 54; Fische der Südsee 3 (1910) 464.

Tetraodon sordidus RÜPPELL, Neue Wirbelt., Fische (1835) 60, pl. 16, fig. 4.

Tetraodon scaber EYDOUX and SOULEYET, Voy. Bonite, Poissons (1841) 214, pl. 10, fig. 1.

Crayracion immaculatus BLEEKER, Atlas Ichth. 5 (1865) 75, pl. 211, fig. 1.

Tetrodon manillensis PROCÉ, Bull. des Sciences, Soc. Philomat. (1822) 130.

Crayracion manillensis BLEEKER, Atlas Ichth. 5 (1865) 69, pl. 208, fig. 2.

Tetrodon virgatus RICHARDSON, Voy. Erebus and Terror, Zoölogy, Fishes (1846) 62, pl. 39, figs. 8 and 9; Voy. Herald, Zoölogy, Fishes (1854) 163, pl. 28, figs. 6 to 8.

Local name: *Mosi*, Visayan.

Dorsal 10; anal 9. Head contained 2.6 to 2.7 times in length; eye 3.7 to 4.75 in head, snout 2.1 to 2.2, interorbital space 1.7

to 2.1, depth of caudal peduncle 2.7 to nearly 3; breadth of body equal to its depth when not inflated and equal or nearly equal to head.

Body elongate wedge-shaped, with a broad stout conical head, the whole fish more or less laterally compressed; snout short, blunt, upper profile straight, chin full, rounded, and projecting; interorbital space broad, flat; nostril filaments large, conspicuous, two-lobed; caudal fin large, its length more or less than that of head; the whole body thickly covered with white or pale bristles, except upon lips and posterior portion of tail. The belly is capable of very great distention. In a number of specimens the body is nearly globose, like an inflated toy balloon, the depth and breadth each $\frac{2}{3}$ of the length.

Color in alcohol gray, brownish to very dark brown above, paler to white under chin and on belly; my specimens all have twelve to twenty or more bluish or blackish parallel longitudinal lines more or less plainly visible on back, sides, and belly, those on the latter usually soon fading; nasal tentacles white; upper and lower margins of caudal always black, posterior end dark; base of pectoral and dorsal very dark, fins pale; lips yellow; often one or more white spots near eyes.

I have examined over forty alcoholic specimens in the Bureau of Science collection, ranging in length from 14 to 107 millimeters, collected in the following localities: Malabon, Manila, and Cavite, Luzon; Mangarin, Mindoro; Bantayan Island; Cebu, Cebu; Busuanga Island; Dumaguete, Oriental Negros; Cabalian, Leyte; Gigaquit, Surigao Province, Cagayan de Misamis, Zamboanga, and Davao, Mindanao; Sitanki; and Sandakan, Borneo.

There are ten living specimens in the Bureau of Science Aquarium, all collected at Calapan, Mindoro, which show considerable variation in color. The back may be dusky gray, mouse color, or silvery brown-gray, with pale belly; the longitudinal lines are usually greenish yellow or golden; in two specimens they are a kind of red on the back, on the belly yellow; a yellow line surrounds the mouth; the fins are nearly colorless or pale yellow.

I have also examined two dried specimens from Manila and one from Batangas, in the University of Santo Tomas Museum, ranging in length from 230 to 305 millimeters.

All the above-mentioned specimens belong to Procé's *T. manillensis*, or variety *virgata* of Günther, none of them showing the adult color state in which the body is uniformly colored, olive or

brownish above and paler below, without spots or bands, though in one or two of the living specimens the longitudinal lines have nearly disappeared. These color phases often seem to have no relation to size or maturity, though the striped form is probably usually immature.

A specimen 203 millimeters long, or 269 millimeters over all, collected at Calapan, Mindoro, is nearly black above, becoming brownish olive on the sides and yellowish white beneath; the bases of the pectorals and dorsal are black, the dorsal dusky; the caudal has a black margin; the pectorals and ventral are yellowish. This specimen likewise differs in its proportions; the head is a trifle more than 3 times in the length; the eye 5.5 in the head and 2.5 in the blunt, very slightly concave snout, which is 2.1 in the head; the interorbital space is very wide, nearly flat, 1.73 in the head; the depth of the caudal peduncle is 2.4 in the head; the caudal fin is very wide with rounded tip, its length equal to the head.

This species has been collected by every naturalist visiting the Philippines during the past century or more. In addition to the localities already named it has been listed from Lubang; Ticao; Iloilo; Cuyo; Sanguisiapo in the Sulu Archipelago; and from the Sulu Sea.

This highly poisonous fish, especially the striped form first described above, is very common in the Philippines; it occurs from the Red Sea and Zanzibar, eastward and southward to northern Australia and throughout Polynesia.

Tetraodon reticularis Bloch and Schneider.

Tetraodon reticularis BLOCH and SCHNEIDER, Syst. Ichth. (1801) 506; JORDAN and SEALE, Proc. U. S. Nat. Mus. 28 (1905) 791; Bull. Bur. Fisheries 26 (1906) 37; SEALE and BEAN, Proc. U. S. Nat. Mus. 33 (1908) 248; JORDAN and RICHARDSON, Bull. Bur. Fisheries 27 (1907) 73.

Tetrodon reticularis GÜNTHER, Cat. Fishes 8 (1870) 296; DAY, Fishes of India (1878) 705, pl. 180, fig. 5; GÜNTHER, Fische der Südsee 3 (1910) 466.

Tetrodon testudineus BLOCH, Ichthyologie 4 (1787) 122, pl. 139 (not of Linnæus), pro parte.

Crayracion testudineus BLEEKER, Atlas Ichth. 5 (1865) 71, pl. 212, fig. 3.

Dorsal 10; anal 10. Head contained 2.3 to 2.4 times in length; eye about 4 to more than 5, snout 2 to 2.3, interorbital 1.9 to 2, and depth of caudal peduncle 2.87 to 3.1 times in length of head.

Body oblong wedge-shaped, little compressed except the caudal peduncle, head large, blunt, and very broad with conical snout more or less convex in profile, and broad muzzle; the broad interorbital space slightly convex, dorsal region back to dorsal fin rather strongly so; nasal filaments conspicuous, coarsely bilobed; caudal fin of moderate size; the whole body, except lips, covered with white bristles. The belly can be distended until it is nearly globose.

Color in alcohol blackish or dark brown with many small white spots or lines above, larger and more conspicuous behind pectorals and on caudal peduncle, passing into long curved or longitudinal lines on sides and belly; white lines partially encircling eyes and curving around gill openings; caudal conspicuously spotted to its tip, the other fins clear whitish or yellowish, with dark or blackish bases; lips whitish.

Here described from a specimen 81 millimeters long, collected by A. L. Day somewhere in the Visayas; and a specimen 112 millimeters long from Samal Island in Davao Gulf, Mindanao. The species has been recorded previously from the Philippines from Cavite, Luzon; Negros; Lubang; and Zamboanga, Mindanao. In the museum of the Ateneo de Manila is a specimen from Cebu, 340 millimeters long, or about 440 millimeters over all. In the University of Santo Tomas Museum are several specimens from Manila Bay, Mindoro, and Cebu; the largest, without definite locality, has a length of 430 millimeters, or 550 millimeters including the caudal fin.

This distinctively marked poisonous fish occurs from the coasts of India to Guam, New Guinea, and New Britain.

The color of a living specimen in the Bureau of Science Aquarium, collected at Calapan, Mindoro, is greenish yellow, with dark brownish yellow lines on belly, sides, and back; these pass into white spots posteriorly on the sides and above; yellowish lines curve upward between and around the gill openings and eyes; the caudal fin is reticulated yellowish and whitish, the other fins all yellowish. As the proofs were being corrected two specimens were caught with hook and line from the dock at Manila and are now alive in the aquarium.

Tetraodon hispidus Linnæus.

- ? *Tetraodon hispidus* LINNÆUS, Syst. Nat. ed. 10 (1758) 333; BLOCH, Ichthyologie 4 (1787) 131, pl. 142; JORDAN and SNYDER, Proc. U. S. Nat. Mus. 24 (1901) 251; JORDAN and EVERMANN, Bull. U. S. Fish Comm. 23¹ (1903) (1905) 427, pl. 66; JORDAN and SEALE, Bull. Bur. Fisheries 26 (1906) 37; JORDAN and RICHARDSON, Bull. Bur.

- Fisheries 27 (1907) 273; WEBER, Fische der Siboga Exp. (1913) 585.
- Tetradon hispidus* LACÉPÈDE, Hist. Nat. Poiss. 1 (1798) pl. 24, fig. 1; RICHARDSON, Voy. Samarang, Fishes 17, pl. 9, figs. 3 and 4; GÜNTHER, Cat. Fishes 8 (1870) 297; DAY, Fishes of India (1878) 706, pl. 183, fig. 2; GÜNTHER, Fische der Südsee 3 (1910) 466, pls. 176 and 177.
- Tetradon stellatus* EYDOUX and SOULEYET, Voy. Bonite, Poiss. (1841) 212, pl. 10, fig. 2 (not of Lacépède).
- Tetradon laterna* RICHARDSON, Voy. Sulphur, Zool. (1843) 124, pl. 61, fig. 2.
- Crayracion implutus* BLEEKER, Atlas Ichth. 5 (1865) 71, pl. 205, fig. 3 (as *Crayracion laterna*).

Dorsal 10; anal 9 or 10. Head 2.3 to 2.6 in length; eyes large, 4 to 5 in head; snout 1.8 to 2.2, interorbital space 2 to 2.3, and depth of caudal peduncle 2.7 to 3.1 in head.

Body short, stout, very thick and rounded forward, tapering to the laterally compressed caudal peduncle; belly capable of very great distension; head broad, with wide blunt snout, upper profile somewhat concave; interorbital space flat or slightly concave; nostrils with bifid tentacles without openings; lips not covering the large, strong, boldly convex teeth. The whole body densely covered with bristly prickles or short slender spines, except on lips, upper part of snout, fin bases, and caudal peduncle; the abdominal spines are stouter and longer, and have two to four roots.

Color in alcohol grayish black, dusky or brown above, very pale to white on the underparts; back, sides, chin, caudal peduncle, and anterior half of caudal fin sprinkled with large circular white spots, those on caudal peduncle much smaller; belly and sides up to base of pectoral marked by longitudinal narrow black stripes which do not extend beyond anal; gill opening margined by a white line, around which is a broad chocolate brown band, this in turn surrounded by a white line; bases of pectorals, dorsal, and anal dark brown; young specimens show dark transverse bars above, one between eyes, one between pectorals, one between pectorals and dorsal, one including dorsal base, and one on caudal peduncle; these bars may be more or less confluent on sides, forming broad vertical dark blotches; some specimens show several broad, elongated, very dark spots or short bars low down on sides; bristles and spines white.

I have examined specimens ranging in length from 31 to 163 millimeters, from the following localities: Culion; Dumaguete,

Oriental Negros; Cabalian, Leyte; Cagayan de Misamis, Caldera Bay, and Zamboanga, Mindanao; Sitanki. It has been recorded previously from Manila, Panay, Cuyo, and Sanguisiapo.

Two large, bulky, and rotund living specimens in the Bureau of Science Aquarium, obtained at Calapan, Mindoro, have the back olive or mouse color, with obscure darker spots, the back, sides, caudal peduncle, and anterior half of caudal fin with many conspicuous white circular spots; the belly is white; the sides below the pectorals and the belly with longitudinal olive or yellowish stripes on one specimen, the stripes lacking on the other; the fins are bright lemon yellow.

The variation in color is very considerable. In life it is more often light olive green above, with pearly or bluish white spots, and with light olive or yellow stripes on the belly.

This easily recognized species is very widely distributed and is common throughout its range, which extends from the Red Sea and the eastern coast of Africa to the Hawaiian Islands, and from the Riu Kiu to the Samoa Islands, Aneiteum, and Panama. This puffer reaches a length of 20 inches, or about 510 millimeters, and is one of the most poisonous members of the group.

Tetraodon mappa Lesson.

Tetraodon mappa LESSON, Voy. Coquille, Poiss. (1826) 102, pl. 5.

Tetrodon mappa GÜNTHER, Cat. Fishes 8 (1870) 293; Fische der Südsee 3 (1910) 464.

Crayracion mappa BLEEKER, Atlas Ichth. 5 (1865) 72, pl. 210, fig. 3 (adult).

Crayracion meleagris BLEEKER, Atlas Ichth. 5 (1865) 72, pl. 210, fig. 1 (young).

Dorsal 11; anal 10. Head equals depth and is contained 2.4 times in length; caudal 0.7 as long as head; snout 1.86, eye 6.6, interorbital space 2.6, and depth of caudal peduncle 3.13 times in head; eye 3.58 times in snout.

The oblong body is much compressed, with slightly convex profile and strongly arched back; the very large head is flattened laterally, with somewhat prominent bony ridges above eyes and broad, nearly flat interorbital space; caudal peduncle comparatively long, not flattened; gill opening large, prominent; the upper teeth project strongly beyond those of the lower jaw; nasal papillæ large, thick, and clumsy in appearance; small but stout white prickles over body except on lips, snout, cheeks, and posterior portion of caudal peduncle; belly distensible, like that of the other tetrodons.

Color in alcohol brown above, becoming nearly white on belly, and with white lower lip; the entire back and sides covered with elongated wavy and irregular or convoluted very dark brown lines, which pass into circular spots under chin; those on sides of head vertical or radiating from eyes; several large irregular black spots on sides below pectorals; many circular or rounded white spots are scattered over the whole body except on belly, but are most numerous on back, between or inclosed by the lines; all the fins with conspicuous dark brown cross-bars forming a more or less evident network; a wide band of deep chocolate brown around anal opening.

Here described from a specimen 505 millimeters long over all, captured at Calapan, Mindoro; for a long time it was kept alive in the Bureau of Science Aquarium, but it died after some years of captivity. In the University of Santo Tomas Museum is the mounted skin of a specimen from Mindanao, with a length of 435 millimeters, or 535 millimeters including the caudal fin. This specimen is labeled *T. hispidus* but is unquestionably *T. mappa*. There is no other Philippine record of this strongly marked and readily distinguished species. This species was originally described from New Guinea; it is known to occur from Singapore and Java to the Pelew Islands.

Tetraodon aerostaticus (Jenyns).

Tetrodon lineatus BLOCH, Ichthyologie 4 (1787) 127, pl. 161 (not of Linnæus); SCHLEGEL, Fauna Japonica (1847) 287, pl. 125, fig. 2, Nagasaki; DAY, Fishes of India (1878) pl. 180, fig. 3.

Crayracion lineatus BLEEKER, Atlas Ichth. 5 (1865) 70, pl. 206, fig. 1, and pl. 212, fig. 1.

Tetrodon aerostaticus JENYNS, Voy. Beagle (1842) 152.

Tetraodon aerostaticus JORDAN and SNYDER, Proc. U. S. Nat. Mus. 24 (1901) 250.

Dorsal 10; anal 9 or 10. Head contained from 2.24 to 2.34 times in length, eye 2.2 times in snout or 4.2 times in head; snout 1.9 times, interorbital space 2.1 to 2.3 times, and the least depth of caudal peduncle 3.5 times or a little less in head; the greatest breadth of head equal to three-fourths or more of the length of head and the uninflated depth of body about equal to head; caudal fin 3.6 to 4 times in head and body.

The wedge-shaped body is short, very deep, and laterally compressed; the greatest width a little behind eyes and in line with the lower part of the gill openings; belly extremely distensible; interorbital space nearly flat, orbital ridges very slightly

elevated; snout short, concave, the large convex upper teeth strongly projecting; caudal peduncle much compressed laterally; anal fin markedly posterior to dorsal.

Entire body, except lips, fin bases, and caudal peduncle, covered with prominent black spines or bristles, those on belly clubbed, but on the other parts of body sharp pointed. Mouth small with black tongue.

The color of a living specimen, 120 millimeters long, in the Bureau of Science Aquarium, was deep dull black above, the belly paler with broad irregular black bands converging toward throat; caudal with large circular black spots; other fins pale lemon yellow, their basal portion black.

In alcohol the same specimen was whitish below, the black bands much more evident; the region about the mouth paler, with small black spots; anus in a circular black spot.

An alcoholic specimen, 111 millimeters long, has a ground color of bluish gray; above and on sides it is covered with more or less circular black spots, all much smaller than eye, smallest and most crowded along the median dorsal portion, largest on the caudal peduncle and fin; broad black bands on belly, the outer ones converging anteriorly; a black ring around vent; pectorals, dorsal, and anal pale with black bases.

The two specimens here described were taken at Calapan, Mindoro, in March, 1924. A very small specimen, approximately 50 millimeters long, was captured at Legaspi Landing, Manila, August 3, 1924, and added to the living collection at the Bureau of Science Aquarium. This species, which is very distinct from any other tetrodons of the Philippine fauna, occurs in the East Indies and northward to Japan. It has been confused much of the time with other species from various parts of the world, but probably occurs throughout the warmer parts of the Indian Ocean and eastward at least to Amboina.

Tetraodon nigropunctatus Bloch and Schneider.

Tetraodon nigropunctatus BLOCH and SCHNEIDER, Syst. Ichth. (1801) 507; GÜNTHER, Cat. Fishes 8 (1870) 293; DAY, Fishes of India (1878) 704, pl. 180, fig. 4; GÜNTHER, Fische der Südsee 3 (1910) 468.

Tetraodon nigropunctatus JORDAN and SEALE, Bull. Bur. Fisheries 25 (1905) 369, text fig. 70 and pl. 35; EVERMANN and SEALE, Bull. Bur. Fisheries 26 (1906) 101.

Crayracion nigropunctatus BLEEKER, Atlas Ichth. 5 (1865) 74, pl. 206, fig. 4.

Dorsal 10; anal 10. Head from 2.2 to 2.8 times in length; eye from 4 to nearly 5.5 times, snout 2 to 2.3 times, interorbital space 2.1 to 2.2 times, and caudal peduncle 2.85 to 3.28 times in head.

Body somewhat elongate, subcylindrical, back strongly arched; head pointed, with a blunt, concave snout, and broad, flat, or nearly flat, interorbital space; belly greatly distensible; caudal fin smaller than in some related species, with moderately convex posterior margin, its length about 3 times in that of head and trunk; entire body except lips and posterior part of caudal peduncle covered with white bristles; in some specimens the bristles may be almost entirely hidden in the skin so that most of the body seems to be smooth.

Color in alcohol brown or blackish above, becoming paler, grayish or whitish, on belly; a few large black irregular spots scattered over body, particularly on belly; snout and around mouth black or very dark brown; anus in a black spot; dorsal and anal brown or blackish, the free margin usually pale; caudal brown or blackish, edged with pale, whitish or yellowish, never black.

Here described from four specimens, 84 to 170 millimeters in length, collected at Puerto Galera and Calapan, Mindoro, and Dumaguete, Oriental Negros. It has been recorded previously from Bacon, Sorsogon Province, Luzon. A lemon yellow albino variety is common in some regions, but is thus far not known from the Philippines.

This species which often looks more like a fur-bearing animal than a fish, reaches a length of 260 millimeters and occurs from Zanzibar on the east coast of Africa, and Mauritius in the Indian Ocean, to the Samoan Islands.

Tetraodon fluviatilis Buchanan-Hamilton.

Tetraodon fluviatilis BUCHANAN-HAMILTON, Acct. Fishes River Ganges (1822) 6, 362, pl. 30, fig. 1; GÜNTHER, Cat. Fishes 8 (1870) 299; DAY, Fishes of India (1878) 707, pl. 183, fig. 1.

Tetrodon nigroviridis PROCÉ, Bull. Sci. Soc. Philomat. (1822) 130.

Crayracion fluviatilis BLEEKER, Atlas Ichth. 5 (1865) 68, pl. 210, fig. 4.

Dorsal 12-13; anal 11-12. Head equal to depth and contained 2.1 to 2.3 times in length; snout 2.35 to 2.5 times, eye $4\frac{1}{2}$ to 4.7 times, interorbital space 1.8 to a little more than twice, and depth of caudal peduncle 2.5 to 2.9 times in head; eye

contained $1\frac{2}{3}$ to twice in snout; length of caudal fin contained 3 to 3.8 times in head and trunk together.

The thick, heavy, somewhat ovate body is subcylindrical anteriorly, compressed posteriorly, with large head and broad blunt snout but little narrowed, sides of head compressed; inter-orbital space convex and very broad; upper profile a continuous arch from tip of snout to origin of caudal fin, highest just posterior to pectoral; mouth wide; caudal fin very broad; belly moderately distensible; small, stout, widely spaced spines over entire body except on snout, chin, and tail.

Color in alcohol brown above, paler on sides, and gray, yellowish, or yellowish white on belly; back and sides more or less thickly sprinkled with large dark brown spots, mostly circular; caudal with many brown crossbars, the other fins clear.

Here described from seven specimens, 32 to 77 millimeters in length, collected by Alvin Seale in 1908 at Sandakan, Borneo; the largest has a length of 102 millimeters over all. This species was described by Procé,⁷ from Manila, and a specimen in the British Museum was obtained in the Philippines by Hugh Cuming, who was in the Islands from 1836 to 1840. Apparently, no one has obtained it in the Philippines since that time.

This little poisonous fish attains a length of 158 millimeters, and occurs in the mouths of rivers and along the coasts of the Indies from the Philippines to Hindustan.

CANTHIGASTERIDÆ

A family of small puffers differing from the Tetraodontidæ in having the back more or less compressed or ridgelike and in having a sharp or pointed snout; the nostrils are absent or feebly developed; vertebræ 8+10. Gill gives the skeletal characters as follows: Medifrontals separated from the supraoccipital by the intervention of the sphenotics, which are connected and laterally expanded, but short; the prosethmoid prominent above, enlarged and narrowed forward.

The family contains a single genus with about twenty species of brilliantly colored and beautifully decorated little puffers of tropical or subtropical seas; apparently none is more than 160 millimeters in length.

⁷ Loc. cit.

Genus CANTHIGASTER Swainson

Canthigaster SWAINSON, Class. Fishes 2 (1839) 194.

The characters of the genus are included above.

*Key to the Philippine species of Canthigaster.**a*¹. Three or four broad, dark crossbands..... *C. valentini*.*a*². No broad, dark crossbands.*b*¹. Back and sides with fine, wavy longitudinal bluish lines.*C. compressus*.*b*². Back and sides without numerous wavy longitudinal bluish lines.*c*¹. Cheeks, back, sides, and caudal fin with large, bluish, dark-edged ocelli*C. papua*.*c*². Sides and belly sprinkled with dark blue dots, much more numerous on sides of head..... *C. bennetti*.*Canthigaster valentini* (Bleeker).*Tropidichthys valentini* BLEEKER, Nat. Tijdschr. Ned. Ind. 4 (1853) 130.*Canthogaster valentyni* BLEEKER, Atlas Ichth. 5 (1865) 80.*Psilonotus valentyni* BLEEKER, Atlas Ichth. 5 (1865) pl. 208, fig. 1.*Tetrodon valentini* GÜNTHER, Cat. Fishes 8 (1870) 305; Fische der Südsee 3 (1910) 474, pl. 172, fig. C.*Canthigaster cinctus* JORDAN and EVERMANN, Bull. U. S. Fish Comm. 23¹ (1903) 433, fig. 189.

Dorsal 9; anal 9. Depth contained 2.1 times, head 2.75 times, and caudal 3.6 times in length; snout contained 1.3 times in head; eye contained 4.14 times in head, 3 times in snout, and 1.55 times in interorbital space, the last named contained 2.6 times; depth of caudal peduncle a trifle more than twice in head.

Body irregularly oblong, much compressed, with a narrow dorsal ridge, concave interorbital space, sharply pointed head, upper and lower profiles forming a blunt triangle, caudal peduncle wide; dorsal and anal fins small and weak; entire body covered with very short, harsh, rather widely spaced prickles.

There is a broad blackish brown crossband behind eyes and above gill openings; a second and broader one above pectorals, descending over base of pectorals in a narrow bar and extending diagonally backward on to abdomen; a third bar in front of dorsal descends nearly vertically almost to middle of abdomen; behind dorsal a broad saddle on caudal peduncle, extending back as a dark bar on upper margin of caudal fin; blotches of similar color about anus and at base of lower margin of caudal; interspaces spotted with many large orange or brown ocelli

which become smaller ventrally and on head; some brown horizontal lines below and behind eye and extending posteriorly to caudal peduncle; very narrow faint dark lines crossing snout transversely and also longitudinal ones on interorbital space, curving downward in front of eye; some pale transverse bands on breast.

The above description is of a specimen 80 millimeters long, or 102 millimeters over all, from Cabalian, Leyte. An old specimen in the Bureau of Science collection, 33 millimeters long, obtained at Puerto Princesa, Palawan, has the ground color bluish white, the interspaces between the dark brown crossbars appearing as conspicuous white lines.

This beautiful little fish is found from Zanzibar to Samoa and Tahiti, and northward to the Hawaiian Islands, if Günther is correct in placing Jordan and Evermann's *Canthigaster cinc-tus* in the synonymy of this species, as I believe he is.

Canthigaster compressus (Procé). Plate 2, fig. 5.

Tetrodon compressus PROCÉ, Bull. Sci. Soc. Philomat. (1822) 130.

Canthigaster compressus JORDAN and SEALE, Proc. U. S. Nat. Mus. 28 (1905) 791; Bull. Bur. Fisheries 26 (1906) 37; EVERMANN and SEALE, Bull. Bur. Fisheries 26 (1906) 101; Proc. U. S. Nat. Mus. 31 (1906) 510; SEALE and BEAN, Proc. U. S. Nat. Mus. 33 (1907) 248.

Tetraodon striolatus QUOY and GAIMARD, Voy. Uranie, Zool. (1824) 203.

Canthogaster striolatus BLEEKER, Atlas Ichth. 5 (1865) 82.

Pylonotus striolatus BLEEKER, Atlas Ichth. 5 (1865) pl. 213, fig. 6.

Tetrodon striolatus GÜNTHER, Cat. Fishes 8 (1870) 304; Fische der Südsee 3 (1910) 473.

Dorsal 9; anal 8. Depth contained twice, head 2.27 to 2.42 times, and caudal 2.75 to 3 times in length; snout 1.5 times or a trifle less in head; eye 3.6 to 3.8 times in head, 2.4 to 2.6 times in snout, and 1.4 to 1.6 times in interorbital, which is $2\frac{3}{8}$ to 2.5 times in head; depth of caudal peduncle 2.1 to 2.25 in head.

Body irregularly oblong, strongly compressed laterally, with pointed head and elongate, slightly concave snout and broad caudal peduncle; a narrow dorsal ridge extends from a point above gill openings to dorsal; interorbital space concave; very small, widely spaced spinules on head and trunk, but absent behind origin of dorsal and anal.

Color in alcohol yellowish brown, dark dorsally and pale ventrally, with fine wavy longitudinal bluish lines along back and sides; broader transverse blue lines between eyes, crossing snout, and continued backward along upper half of head; below these

are small rounded or irregular bluish spots; a large dark ocellus with a blue margin on each side below base of dorsal; caudal yellowish, cross-barred with vertical bluish lines; the other fins all pale yellowish.

Here described from two small specimens 41 and 46 millimeters long, collected at Bantayan Island. Another specimen, 44 millimeters long, in the Bureau of Science collection, came from Sorsogon Province, Luzon. This species was originally described from Manila and occurs commonly about Celebes and the Spice Islands and eastward to Faté, one of the New Hebrides.

Canthigaster papua (Bleeker).

Tetraodon papua BLEEKER, Journ. Ind. Arch. 2 (1848) 638.

Tetrodon papua GÜNTHER, Cat. Fishes 8 (1870) 301; Fische der Südsee 3 (1910) 471.

Canthogaster margaritatus BLEEKER, Atlas Ichth. 5 (1865) 82.

Psilonotus margaritatus BLEEKER, Atlas Ichth. 5 (1865) pl. 213, fig. 4.

Tropidichthys papua WEBER, Fische der Siboga Exp. (1913) 587.

Dorsal 9; anal 9. Depth 1.9, head 2.5, and caudal 3.38 times in length; snout 1.5 times, interorbital $1\frac{2}{3}$ times, and depth of caudal peduncle 1.7 times in head; eye 4 times in head, $2\frac{2}{3}$ in snout, and 1.5 in interorbital.

Body roughly oblong, rather thick but compressed laterally, with the portion behind dorsal and anal very wide and strong; head bluntly pointed, with concave snout and broad, very slightly concave interorbital space; the portion behind dorsal and anal smooth, the rest of trunk and head covered with small, feebly developed prickles.

Color in alcohol brown, paler on belly, with many large dark-edged ocelli scattered over cheeks, back, sides, and caudal fin; a large dark spot on each side at base of dorsal fin, encircled anteriorly by an incomplete bluish line which passes backward along top of caudal peduncle instead of curving upward to complete the circle; transverse dark brown lines across interocular space and snout and curving downward and backward on cheeks; some dark lines radiating posteriorly from eyes; a dark brown median line on belly from chin to anus.

Here described from a specimen 61 millimeters long, obtained at Dumaguete, Oriental Negros, by the zoölogical department of Silliman Institute.

I place here a specimen, 57 millimeters long, collected at Guam by R. C. McGregor. In this specimen the large bluish

ocelli are very well marked, though their darker margin is not so clearly defined. The snout is more pointed and the color much paler than in the Dumaguete specimen. The line on the belly has almost disappeared. The Bureau of Science collection also contains a specimen, 46 millimeters long, from Bantayan. Weber collected a specimen 13 millimeters long in surface plankton at North Ubian, an island of the Sulu Archipelago.

This very handsome little puffer occurs in the East Indies and in the Pacific to the Mariana Islands and the Bismarck Archipelago. Bleeker's *C. margaritatus* is not *Tetrodon margaritatus* of Rüppell.

Canthigaster bennetti (Bleeker).

Tetrodon ocellatus BENNETT, Fishes Ceylon (1834) 21, pl. 21 (not of Bloch).

Tropidichthys bennetti BLEEKER, Nat. Tijdschr. Ned. Ind. 6 (1854) 504; WEBER, Fische der Siboga Exp. (1913) 586.

Canthogaster ocellatus BLEEKER, Atlas Ichth. 5 (1865) 80.

Pailonotus ocellatus BLEEKER, Atlas Ichth. 5 (1865) pl. 214, fig. 5.

Tetrodon bennetti GÜNTHER, Cat. Fishes 8 (1870) 301; Fische der Südsee 3 (1910) 471.

Canthigaster bennetti EVERMANN and SEALE, Bull. Bur. Fisheries 26 (1906) 101.

Dorsal 9; anal 8. Depth contained 2.46, head 2.875 times in length; snout contained 1.5 times in head; eye contained 4.8 times in head, 3.2 times in snout, and 1.6 times in interorbital space which is contained 3 times in head and twice in snout; caudal peduncle contained 2.18 times in head.

Body elongate oblong, laterally compressed but rather thick and somewhat rounded posteriorly, head deep and narrow with long and pointed snout; upper profile straight, interorbital space slightly concave; very fine prickles over body except behind anus and posterior portion of caudal peduncle.

An alcoholic specimen 69 millimeters long, collected at Cabalian, Leyte, is colored as follows: The dorsal half is dark, with brown and bluish black irregular spots and bands, forming angles behind dorsal with the points of the angles directed backwards; lower half of sides and belly pale, whitish; sides and belly sprinkled with small dark blue circular dots intermingled with white circular spots; these spots are most numerous on sides of head; on tail and in lower portion of dark part of sides the blue dots are widely separated and ocellated, with a broad white ring; several dark blue horizontal lines crossing eye and continuing forward on snout, the lower ones alternating

with white lines; three short, dark blue, white-margined vertical bands on each side of snout behind mouth; a large dark spot with an incomplete blue or bluish marginal line about it on base of dorsal; a bluish line from behind chin along median line of throat and forward part of belly; the rays of the pectorals dusky, the rest of the fins clear.

I have also examined four small specimens from 35 to 50 millimeters in length, collected at Bacon, Sorsogon Province, Luzon; Caldera Bay, Mindanao; and Sitanki. These agree in all essentials with the one described, except that the color is more brown above and yellowish brown on the lower half of body, while the snout in some is slightly convex. This beautiful little puffer reaches a length of about 100 millimeters and occurs from Zanzibar, on the east coast of Africa, to Ponapé in the Caroline Islands and to Tahiti in the South Seas. It has been previously recorded from the Philippines from Bacon, Sorsogon Province, Luzon, and from North Ubian, one of the islands of the Sulu Archipelago.

DIODONTIDÆ

PORCUPINE FISHES; BOTTING LAOT

The stout broad body is almost flat above and the head end is nearly square in living, uninflated specimens; the belly is moderately to greatly distensible, everywhere covered with spines except on the lips and caudal peduncle; the hard stiff spines have a bony base and may be two-rooted and erectile or three-rooted and immovable; the mouth is of medium size, terminal, each jaw covered by an entire bony beaklike plate, without joints; the nostrils on each side form a small tentacle, usually with two openings; the eyes are large, often protruding; the gill opening is of medium size, immediately in front of the pectoral, which is short, rounded, and very wide; the dorsal and anal fins are far back, nearly alike in size and shape, and nearly opposite each other.

These fishes of warm seas are widespread in the Tropics, where they are common about coral reefs, while their singular form and armor have caused them to be carried to all parts of the world as curios. Like the puffers they swallow air until they are nearly helpless and become more or less globose and porcupine-like, floating belly up at the surface.

The fishes of this family have a well-deserved reputation for being poisonous, and their flesh should never be eaten.

Of the half dozen genera known, two occur in the Philippines.

Key to the Philippine genera of Diodontidæ.

- a*¹. Dermal ossifications all or nearly all with two roots, the spines long and erectile *Diodon*.
*a*². Dermal ossifications all or nearly all with three roots, the spines short, stout, immovable..... *Chilomycterus*.

Genus *DIODON* Linnæus

Diodon LINNÆUS, Syst. Nat. ed. 10, 1 (1758) 335.

Body robust, head and anterior part squarish; the stout, stiff, and very sharp spines mostly two-rooted and erectile; a few only are three-rooted and therefore immovable; the simple nasal tube has two lateral openings.

The species of this readily recognized genus are few in number, but are very widely distributed in the tropical and warm temperate portions of the ocean.

Key to the Philippine species of *Diodon*.

- a*¹. Entire body or all except belly with numerous small circular dark spots *D. hystrix*.
*a*². Body not spotted as above.
*b*¹. Thirteen to sixteen spines from snout to dorsal, eighteen to twenty across belly between pectorals; orbital spines equal to or much longer than eye..... *D. holacanthus*.
*b*². Eighteen to twenty spines from snout to dorsal, twenty-six to twenty-eight across belly between pectorals; orbital spines much less than eye diameter..... *D. bleekeri*.

Diodon hystrix Linnæus.

Diodon hystrix LINNÆUS, Syst. Nat. ed. 10, 1 (1758) 335; GÜNTHER, Cat. Fishes 8 (1870) 306; DAY, Fishes of India (1878) 708, pl. 179, fig. 4; JORDAN and EVERMANN, Fishes N. and M. America 2, U. S. Nat. Mus. Bull. 47 (1898) 1746, pl. 266, fig. 648; Bull. U. S. Fish Comm. 23¹ (1903) 437, fig. 192; GÜNTHER, Fische der Südsee 3 (1910) 474.

Diodon atinga BLOCH, Ichtyologie 4 (1787) 75, pl. 125.

Paradiodon hystrix BLEEKER, Atlas Ichth. 5 (1865) 56, pl. 207, fig. 2.

Diodon punctatus PETERS, Monatsber. Akad. Wiss. Berlin (1868) 276.

Dorsal 13; anal 12. Head contained 2.5 times, caudal 4.2 times in length; eyes large, 3.8 times in head and 1.6 times in snout, which is $2\frac{1}{3}$ times in head; interorbital flat, very broad, 1.4 times in head; depth of caudal peduncle about the same as eye diameter.

Body thick, heavy, somewhat elongate, very broad anteriorly, tapering posteriorly, with rather rounded caudal peduncle, snout very short, very slightly concave, mouth wide, the lower dental plates rounded, the upper hardly convex, with roughened margin

at center; spines long, stout, with broad base, over entire body except snout and sides of tail, those behind pectorals largest; those on posterior part of back short and at least some of them three-rooted; two or three pairs of nonerectile spines on top of caudal peduncle between dorsal and anal fins and also on its ventral surface.

Color in alcohol brownish gray, darker above and nearly white on belly; upper part of head and trunk and sides and fins thickly sprinkled with rather small circular or rounded dark spots, smallest and most numerous anteriorly, larger and farther apart on caudal peduncle; a brown band passes under chin from eye to eye and is curved forward behind chin. The spots are brown but according to authors may be blue.

Here described from a specimen 210 millimeters long, collected at Sitanki. There is a very large specimen in the Ateneo de Manila Museum, obtained at Cavite, which is 470 millimeters long, with a total length of 570 millimeters, and with two dark brown transverse bars on dorsal and caudal fins; and another specimen, 240 millimeters long, from Surigao, Mindanao. In the University of Santo Tomas Museum is a small specimen from Manila Bay. Specimens of this species were collected by Jagor at Paracale, Camarines Norte, Luzon. It occurs in the tropical Pacific, Indian, and Atlantic Oceans, and is found in many curio collections.

Diodon holacanthus Linnæus.

Diodon holacanthus LINNÆUS, Syst. Nat. ed. 10, 1 (1758) 335 (based on Artedi; misprint for *holacanthus*); JORDAN and EVERMANN, Fishes N. & M. America 2, U. S. Nat. Mus. Bull. 47 (1898) 1746; JORDAN and SNYDER, Proc. U. S. Nat. Mus. 24 (1901) 257; JORDAN and EVERMANN, Bull. U. S. Fish Comm. 23¹ (1903) 436.

Diodon quadrimaculatus, *sexmaculatus*, *novemmaculatus*, *multimaculatus* CUVIER, Mém. Mus. Hist. Nat. 4 (1818) 136-138, with figures, pls. 6 and 7.

Diodon novemmaculatus SCHLEGEL, Fauna Japonica, Poiss. (1847) 289, pl. 128, fig. 2.

Paradiodon quadrimaculatus BLEEKER, Atlas Ichth. 5 (1865) 58, pl. 212, fig. 2.

Diodon maculatus GÜNTHER, Cat. Fishes 8 (1870) 307; Fische der Südsee 3 (1910) 475.

Dorsal 12; anal 12. Head contained 2.25 times, caudal fin $5\frac{1}{11}$ times in length; the large prominent eyes 3.57 times in head and nearly equal to snout, which is $3\frac{1}{8}$ times in head; the wide and nearly flat interorbital $1\frac{2}{3}$ times, depth of caudal peduncle $8\frac{1}{3}$ times in head.

Body wedge-shaped, very broad and stout anteriorly, with flattened dorsal and ventral surfaces, or back gently rounded; snout straight or nearly so, jaws rounded, the upper hardly convex; entire body except lips covered with long spines, all two-rooted and erectile except those on hind part of body, which may be three-rooted; three or four spines at least an eye diameter in length above each eye and two long spines between anterior pair; frontal spines longer than those behind pectorals; fourteen rows of spines between snout and dorsal fin in my specimen; thirteen to sixteen rows according to Günther; there are eighteen to twenty rows of spines across belly between the pectorals.

Color in life brownish gray above, nearly white beneath, with a series of broad velvety brown transverse bands and spots; the first is on interorbital space from eye to eye and downward on side as a pointed stripe to undersurface; midway between this and pectorals is another wide crossbar; on sides behind and above pectorals is a crescent-shaped spot; farther behind on middle of back is another spot; a similar spot about base of dorsal; small rounded or elongate blackish spots scattered over whole body; the protuberant eyes greenish; fins colorless.

Color in alcohol pale brown above, shading off to creamy white on belly; the markings as above indicated, the colors duller.

Here described from an alcoholic specimen, 56 millimeters long, collected at Jolo, and two much larger living ones, obtained at Calapan, Mindoro, the larger one of these about 180 millimeters in length. In the Ateneo de Manila Museum is a specimen from Cavite. It was recorded by Günther from the "Sooloo Sea."

A specimen from Mindoro in the University of Santo Tomas Museum, labeled *D. spinissimus*, probably belongs here. It is 215 millimeters long and has exceedingly long spines above, between, and forward of the eyes, twice or more than twice the diameter of an eye.

This species occurs in all warm waters of the Pacific, Indian, and Atlantic Oceans.

Diodon bleekeri Günther.

Paradiodon novemmaculatus BLEEKER, Atlas Ichth. 5 (1865) 57, pl. 206, fig. 3 (not of Cuvier).

Diodon maculatus var. β GÜNTHER, Cat. Fishes 8 (1870) 308.

Diodon bleekeri GÜNTHER, Fische der Südsee 3 (1910) 475, pl. 178.

Dorsal 14; anal 14. Orbital spines much shorter than diameter of eye, the longest about 0.72 of eye; spines behind pectorals longest, some of them equaling eye; apparently all the spines are two-rooted and erectile; no spines or bony plates on caudal peduncle behind dorsal and anal, the two spines lying along its side anteriorly having their roots opposite dorsal; eighteen or twenty spines in a row between snout and dorsal; twenty-six to twenty-eight in a row from pectoral to pectoral across belly; length of pectoral fin less than half its breadth; belly capable of great distension.

Color in alcohol brown above, becoming yellow on belly, with a small dark brown spot behind each spine on sides behind pectorals; remainder of body and fins unspotted; nine large, blackish brown, white-margined spots or crossbars on upper parts as follows: The first across each eye and downward as a broad bar toward belly; the second across top of head, nearer pectorals than eyes; a short bar in front of each gill opening; a large nearly circular spot above and behind each pectoral; a still larger, nearly circular spot on middle of back; the last dark area surrounds base of dorsal fin.

Here described from a specimen, 275 millimeters long, obtained at Manila.

This species reaches a length of 360 millimeters and occurs in the East Indies from Sumatra and Singapore to New Guinea, and southeastward in the Pacific to the Society Islands.

Genus *CHILOMYCTERUS* Bibron

BURFISHES; RABBIT FISHES

Chilomycterus BIBRON in Barneville, Rev. Zool. (1846) 140.

The broad, flattened body is much like that of *Diodon*; the spines are very much shorter and stouter, stiff, erect, immovable, somewhat triangular, all or nearly all with three roots each, their expanded bases forming a coat of mail; the simple nasal tube has two lateral openings; the tube is sometimes rounded and sometimes flattened, with a weak and easily torn partition so that it may appear divided; the caudal peduncle is rather short.

The species are usually smaller than those of *Diodon*; one is known from the Philippines.

Chilomycterus orbicularis (Bloch).

Diodon orbicularis BLOCH, Ichtyologie 4 (1787) 81, pl. 127; BLEEKER, Atlas Ichth. 5 (1865) 55, pl. 205, fig. 4.

Chilomycterus orbicularis GÜNTHER, Cat. Fishes 8 (1870) 312; Report Voy. Challenger, Zool. 1 (1880) Report on Shore Fishes, 54.

Diodon caeruleus QUOY and GAIMARD, Voy. Uranie, Zool. (1824) 201, pl. 65, fig. 5 (young).

Head 2.25 times, caudal fin 3.8 times in length; the large protuberant eyes about 3.25 times in head and nearly equal to snout, which is a third as long as head; interorbital space $2\frac{1}{3}$ times in head; caudal peduncle small and weak, its depth 7 times in head.

The spines are all three-rooted, short, sharp, and very strong, with low, widespreading roots; a row of three spines above each eye, their bases forming a ridge convergent toward front; a single spine in middle of forehead midway between anterior ends of orbital ridges; eight or nine rows of spines between snout and dorsal fin; tail spineless, but the roots of a single pair of spines extend across behind dorsal fin; mouth rather wide, horizontal, lower jaw rounded, upper one obtusely pointed. This fish can distend itself until it is nearly globular.

Color brown above, marbled with darker bands, whitish on belly; fins brown, more or less transversely banded with darker.

Here described from a curiously deformed specimen, 95 millimeters long, collected at Manila in 1911 by Alvin Seale. Specimens of this species were taken by the *Challenger* off the coast of Cebu at a depth of 18 fathoms. In the collection of the Ateneo de Manila is a dried specimen from Cavite, Manila Bay, and one 245 millimeters long from Tandag, Surigao Province, Mindanao. In the University of Santo Tomas Museum are two specimens from Mindoro and one from Batangas, the larger one about 305 millimeters in length.

This species is apparently confined to the East Indies and the Indian Ocean.

MOLIDÆ**HEADFISHES**

These singular and preposterous-looking fishes of the open sea are apparently nothing but an enormous head, or the anterior third of a large fish, with a little frill behind and a long knifelike fin protruding at right angles to the body above and below, just forward of the frill-like caudal. Two genera are known, *Mola* and *Ranzania*. The first named contains but a single species, nearly circular, and attaining a diameter of 8 feet (about 2.5

meters) or more. *Mola mola* (Linnæus), the sunfish or headfish of the open sea, has thus far not been reported from the Philippines, though unquestionably it must occur along the eastern shores of the Archipelago from time to time. It is a poor swimmer, as far as known, and is carried by ocean currents over all temperate and tropical seas. The other genus has been collected in Philippine waters.

The body is oblong or short and deep, compressed, truncate behind, so that the fish appears bitten off. The skin is rough and naked, spinous, or tessellated. The mouth is terminal and very small; the teeth in each jaw are completely united, forming a bony beak without a median suture, as in the Diodontidæ. The dorsal and anal fins are very much alike, falcate, and may be more or less confluent with the caudal; there is no spinous dorsal and no ventral fins are present; the pectorals are behind the small gill openings; there is an accessory opercular gill; there is no air bladder and the belly cannot be inflated.

The very young are spinous and very much shortened in form. The flesh of the headfish is coarse, tough, and of doubtful edibility; that of *Ranzania* is said to be good.

Genus RANZANIA Nardo

Ranzania NARDO, Ann. Soc. Regn. Lombard. Venet. 5 (1840) 10, 105.

Body greatly compressed, oblong, depth $\frac{4}{7}$ to a trifle more than 0.5 of length; skin smooth, tessellated, divided into small hexagonal scutellæ; caudal truncate; dorsal and anal long, narrow, falcate. Strange fishes of the open sea, looking like the anterior third of a fish, with a frill added for a tail; apparently they do not grow to much more than 600 millimeters in length. Two species are known, one from the Mediterranean and the Atlantic Ocean about Madeira; and the other, which may not be distinct, known from six examples in the Pacific Ocean.

Ranzania makua Jenkins.

Ranzania makua JENKINS, Proc. Calif. Acad. Sci. II 5 (1895) 780, 784, with plate; JORDAN and SNYDER, Proc. U. S. Nat. Mus. 24 (1901) 262; JORDAN and EVERMANN, Bull. U. S. Fish Comm. 23¹ (1903) 440, fig. 194.

Dorsal 17; anal 18. Depth 1.75 times, head 2.5 times, and caudal fin $11\frac{2}{3}$ times in length; eye 7 times in head and 2.5 times in snout, which is $\frac{1}{4}$ of the length and is 2.8 times in head.

Body greatly compressed and of strange appearance, being apparently but the head of a large fish; dorsal margin gently

convex anteriorly, then low and nearly straight; ventral margin a convex, evenly curved keel; dorsal and anal fins elongate, narrow, dorsal fin erect, anal slanted obliquely backward; eye above axis of body and above mouth.

The color is uniform silver, without trace of the beautiful life colors and bands shown in the handsome plate accompanying Jenkins's description.

Here described from a stuffed specimen in the Ateneo de Manila Museum. This specimen, which came from Samar, has the following dimensions: Length, 350 millimeters (including caudal, 380); depth, 200; distance from tip of dorsal to tip of anal, 330; head, 140; snout, 50; eye, 20.

This rare fish, which attains a length of half a meter, is known only from four examples from Hawaii, the type locality, and a Japanese painting made about 1850, representing a specimen caught "off the Sea of Akabane in Mikawa." Unlike other gymnodonts, this fish swims with almost incredible rapidity.

Günther unites this species with *Ranzania truncata* Nardo, of the Atlantic Ocean, from which it is only doubtfully distinct. Whether he is correct or not in doing so can only be settled by a comparison of ample material.

ILLUSTRATIONS

PLATE 1

- FIG. 1. *Balistapus undulatus* (Park).
2. *Odonus niger* (Rüppell).
3. *Monacanthus chinensis* (Bloch).
4. *Stephanolepis tomentosus* (Linnæus).

PLATE 2

- FIG. 1. *Cantherines macrurus* (Bleeker).
2. *Cantherines sandwichiensis* (Quoy and Gaimard).
3. *Orymonacanthus longirostris* (Bloch and Schneider).
4. *Spheroides lunaris* (Bloch and Schneider).
5. *Canthigaster compressus* (Procé).

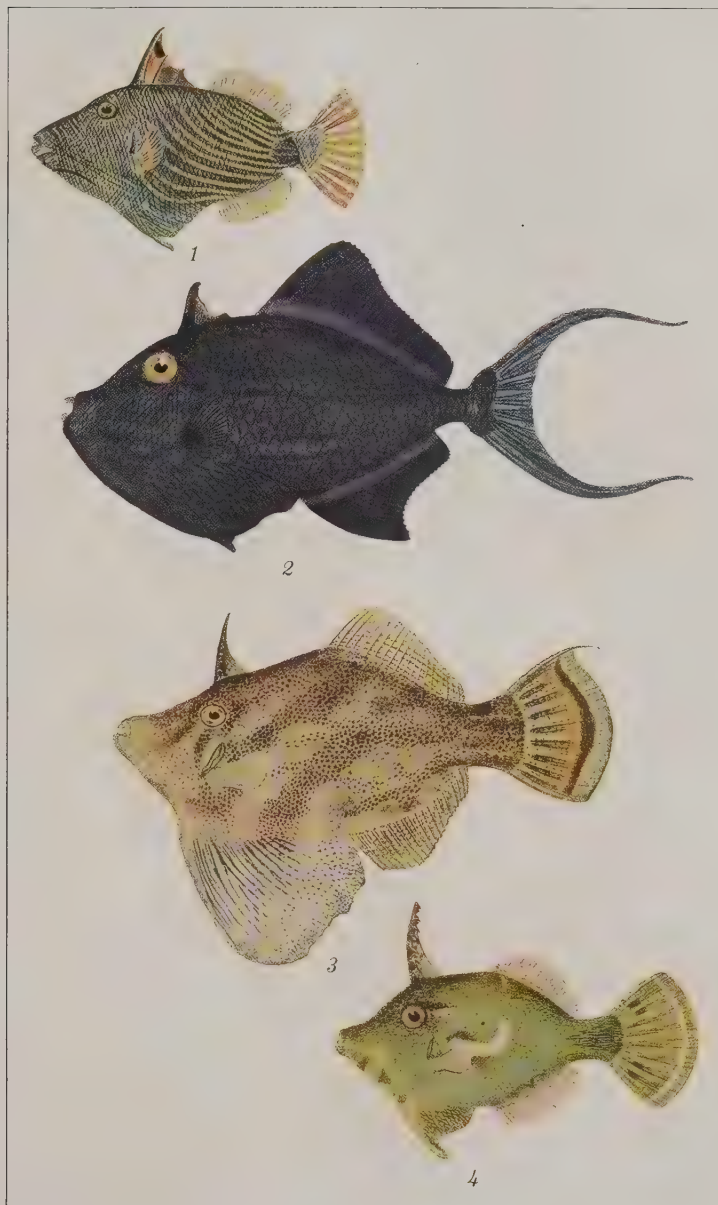


PLATE 1.



PLATE 2.

SOME DEPARTURES FROM THE TYPICAL CELL PICTURE
OF BACILLARY AND AMŒBIC DYSENTERY WITH
SPECULATIONS AS TO THEIR SIGNIFICANCE, I

OBSERVATIONS ON SOME POST-BACILLARY EXUDATES, AND ON THE
PRESENCE OF EOSINOPHILES IN INTESTINAL ALLERGY

By FRANK G. HAUGHWOUT
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EIGHT PLATES

When Willmore and Shearman(7) published their paper on the differential diagnosis of the dysenteries by the microscopic examination of the bowel exudate, they placed before such physicians and microscopists as have familiarized themselves with it a system of procedure that most certainly has reduced the mortality from these disorders in a very substantial degree. Though not spectacular in the sense that cholera, smallpox, leprosy, and yaws are spectacular, dysentery is, none the less, a steady drain on the population of every community in the Tropics, and is not by any means a negligible factor in the public-health problem in certain communities lying in temperate climates.

Summed up, Willmore and Shearman accomplished two vitally important things; they described a method by which it becomes possible to institute specific treatment against bacillary dysentery within two or three hours of its onset—a desideratum most important to the successful management of this condition; secondly, they established the sharp distinction between the exudate produced by *Bacillus dysenteriae* and that accompanying the uncomplicated activities of *Entamoeba histolytica*, showing that a heavy leucocytic exudate is not a feature of simple amœbic dysentery.

The fundamental principles established by Willmore and Shearman have been confirmed since, and additions to our knowledge bearing on the significance of bowel exudates have been made by Bahr and Willmore,(2) Anderson,(1) Haughwout,(3, 4, 5, 6) and others. This paper is one of a series in which I

shall record the results of my own observations in the study of dysenteric and other intestinal exudates I hope to show, by these observations, that the applicability of the method extends beyond the limits set by Willmore and Shearman—that is to say, the differential diagnosis of acute dysentery—and that careful study of these exudates often yields information of the greatest importance in connection with the clinical management of a number of acute to subacute conditions in the lower intestinal tract. It is my intention in this particular paper, to record some observations I have made in certain post-dysenteric cases, with the aim to emphasize the vital importance of continuing the microscopic study, through convalescence and for a while subsequent thereto, of the fæces of patients who have suffered from bacillary dysentery. This is a procedure that frequently is carried out after amœbic dysentery to determine if the subject has been cleared of his infection, but it is not ordinarily followed after bacillary dysentery. I also shall offer a few remarks on the presence of eosinophile cells in bowel discharges.

Proceeding to the first topic, the microscopic study of the fæces of post-bacillary subjects, we have to deal with two rather distinct cell pictures; first, that presented by the more or less regressive cytological changes that include the progressive decline in numbers of endothelial macrophages and the subsidence of cellular evidence of toxic necrosis in cells of all types; this picture gradually shades into the second cell picture, that is the expression of a residual purulent process in unhealed areas in the colon and in which *Bacillus dysenterix* probably plays little, if any, part. In the latter stage, annular degeneration of leucocyte nuclei usually becomes less marked and the nuclei tend to regain their normal lobed and homogeneous appearance. This stage, in some instances, is succeeded by a desquamative process in the colon in which large numbers of columnar epithelial cells in various stages of degeneration are cast off and form a very distinctive exudate. These epithelial cells frequently form the major portion of the exudate, leucocytes being scarce or totally lacking. I shall speculate on the significance of these appearances, but in full realization that much work remains to be done before the meaning of them will be made clear. However, of themselves, these exudates should afford the clinical man engaged in the treatment of dysentery much food for reflection even if, for the time being, they lead him to nothing better than empirical treatment.

I am frank to say that I am no great believer in chronic bacillary dysentery as a condition of frequent occurrence. That pathologic processes caused by *Bacillus dysenterix* occasionally do run a chronic course is not improbable. However, it is my belief that careful study of the intestinal exudate affords us the best proof we have at present that most of the chronic processes following acute bacillary dysentery are caused by organisms or conditions bearing no existing relation to the activities of the dysentery bacillus. In my judgment, these conditions should be appraised and treated on the basis of the rather definite evidence that most of them afford and which can readily be secured through the intelligent use of the microscope.

As has been said, treated cases of amœbic dysentery usually are followed microscopically for a period of time, in order to discover if the patient resumes the passage of cysts of *Entamœba histolytica* which, if found, serve as the indication for the repetition of treatment. However, the search for cysts seldom is accompanied by an equally thorough search for cellular detritus, such as stray polymorphonuclear leucocytes or epithelial cells. Post-amœbic cases, in my experience, occasionally yield evidence of residual ulceration of a mild degree long after it has become impossible to demonstrate cysts in the fæces. When cellular detritus of this kind is found in post-amœbic cases it should receive attention aside from that given to the chronic amœbic condition.

On the other hand, such procedure seldom or never is followed after recovery from the acute symptoms of bacillary dysentery. The almost spectacular response of patients to anti-dysenteric serum in the milder manifestations of dysentery of the "Flexner type" is, to my mind, responsible for a false sense of security on the part of clinical men, although in justice it must be said that the criteria on which the truth is based rest on microscopic study of the fæces. Under serum, and not infrequently without specific treatment, the bowel movements will lose their mucopurulent character and become formed and fæculent by the third day. This condition usually is the signal for a cessation of serum treatment, especially as the constitutional reaction subsides coincidentally. In consequence, the case is regarded as clinically cured and the patient, who has been on short rations meanwhile, returns to his customary gastro-nomic routine with enthusiasm. It thereupon devolves upon the

microscopist to furnish the evidence that will lead the clinician to measures designed to ward off permanent damage to the patient's colon. I shall illustrate this specifically below, but at this place I would remark that a not inconsiderable number of these patients yield evidence that an active dysenteric process is still in progress. Inspection of the formed faecal masses in these cases will show an investiture of mucus, and microscopic study of this often will disclose a heavy leucocytic exudate containing endothelial macrophages and other cellular evidence of an acute bacillary process. It is problematical how much benefit may be expected from the administration of antidyseric serum at this stage, or even if it is necessary to give it; that is a nut for the clinicians to crack. The fact remains that the evidence indicates that the dysentery bacillus is still at work, and it is cases such as these that swell the roll of those who develop chronic ulcerative conditions of the colon which, if allowed to go on unchecked, lead to permanent pathologic changes in the large intestine.

As a prelude to the consideration of specific cases in point, it seems opportune briefly to review the cytology of the exudates occurring in acute bacillary and acute amœbic dysentery. To this end the reader is referred to Plates 1 and 2, which show fields from the commoner types of bacillary and amœbic exudates, respectively.

The salient features upon which rests the cytodiagnosis of bacillary dysentery are the presence in the bowel exudate of:

1. A massive content of polymorphonuclear neutrophile leucocytes, amounting to about 90 per cent of the total cell content.

2. The presence in varying proportions (about 2 to 10 per cent) of endothelial macrophage cells varying from 15 μ to 20 μ in diameter, many of which will be seen to have phagocytosed erythrocytes.

3. Evidence, in the various cells composing the exudate, of an extreme necrotic process consequent upon a bacterial invasion of great toxicity. This is evidenced by a uniform and simultaneous destruction extending to all parts of the cell. In extreme cases only the cell membrane and a slight residuum of former protoplasmic substance remain, such constituting the so-called "ghost cells" which, with the macrophages, are diagnostic of bacillary dysentery. The exudate of bacillary dysentery is the only product of the bowel that yields this cellular picture. Cells of other types, such as epithelial cells, plasma cells, and leuco-

cytes of various kinds, occur in small and varying proportions; but, for the purposes of diagnosis, they may be disregarded in the presence of the picture I have outlined.

The most striking variation one sees in the general run of exudates of bacillary dysentery lies in the proportion that the endothelial macrophages bear to the remainder of the exudate. In some instances they are relatively few in number, although one scarcely ever encounters a low-power field in which at least two or three cannot be discovered. Such an exudate is shown in Plate 1, fig. 1. In other instances, the macrophages are much more conspicuous, often tending to collect in more or less segregated masses, as shown in Plate 1, fig. 2. The exudates from which these preparations were made were taken from separate cases, each of which yielded a growth of *Bacillus dysenteriae* (Flexner type) on bacteriological media. I have not been able to correlate these variations with any corresponding variation in clinical symptomatology.

The one salient feature of the exudate of amœbic dysentery is the presence of tissue-dwelling (trophozoite) forms of *Entamoeba histolytica*. Amœbic exudates are mucoid or mucofæculent and contain small numbers of polymorphonuclear leucocytes, lymphocytes, and epithelial and plasma cells. Quantitatively, the exudate of uncomplicated amœbic dysentery is very scant, as may be seen on inspection of the two figures composing Plate 2. Endothelial macrophages do not enter into its composition. Nearly all the cells show pathological changes, probably largely due to the action of the untoward environment in which they find themselves. Some may always be found, however, that show a type of degeneration that is characteristic of protozoal dysentery. This seems to be a proteolytic process initiated by the organisms in their customary nutritive activities. Destruction of the cell commences at the periphery, the nucleus remaining intact until practically the entire cytoplasm has been destroyed. These little masses of chromatin occur abundantly in the stools of amœbic and balantidial dysentery and they are called "pyknotic bodies."

As with bacillary dysentery, there are two general types of amœbic exudate. One, illustrated in Plate 2, fig. 1, that is almost devoid of cellular elements aside from the amœbæ, pyknotic bodies, and scattering mononuclear cells of various types, is the so-called simple amœbic exudate. It usually is seen in first attacks of amœbic dysentery and signifies that there is very little secondary bacterial infection of amœbic ulcers.

The second type of amoebic exudate is illustrated in Plate 2, fig. 2. It is the characteristic stool of chronic amoebic dysentery (usually faeculent) and, as will be seen on inspection of the figure, carries on its face the evidence of secondary bacterial infection of amoebic ulcers in the form of somewhat numerous polymorphonuclear leucocytes. Study of these leucocytes will show that virtually they are intact. The nuclei have not undergone the annular degeneration characteristic, in an exaggerated degree, of bacillary dysentery, though it is not by any means restricted to that condition; the cytoplasm is not necrotic and, in many of them, there is no indication of the proteolytic digestion characteristic of amoebic dysentery. In short, these leucocytes are the product of neither bacillary nor amoebic dysentery but, on the contrary, bear evidence of being the expression of a low-grade bacterial invasion of the amoebic ulcers. The preparation was made from material taken from an old and intractable amoebic infection. The patient maintained an almost constant leucocytosis of 12,000 to 14,000 during the period I had the case under observation. Repeated efforts were made to secure a growth of *Bacillus dysenteriae* from each of these cases, but in no instance was the effort successful.

Having outlined the characters of the four principal types of dysenteric exudate, I shall now proceed to a discussion of some of the variations from these pictures that one encounters, and the significance that, in my judgment, should be attached to them. To do this I shall cite specific cases that were referred to me for study of conditions, the nature of which could not be determined clinically. I might say at this time, that the first four patients (cases B, R, T, and P) all suffered from bacillary dysentery of a mild type. In no instance was there any hyperpyrexia, and the constitutional symptoms were relatively mild. Moreover, none of these patients received antidyenteric serum. In every case the acute symptoms rapidly subsided and within a few days each patient had resumed his, or her, normal activities. These cases are similar to scores that I have studied in the past few years, and I cite them principally to show how completely dependent the clinical man is upon the microscopist for information as to the progress his patient is making, for in no instance did the physical reactions of the patient give any definite clue to the pathologic process that was perfectly apparent on microscopic study of the bowel discharges.

CASE B

Young American male. He had been on a business trip to Mindanao and on the day of his departure for Manila was attacked with abdominal cramps accompanied by purging. His evacuations quickly became mucoid and blood-streaked and he had some fever—how much, he did not know. He boarded the boat for Manila. On the trip north he improved somewhat, but was still sick when he arrived in Manila on the morning of the fifth day after onset. The patient immediately went to his family physician who referred him to me for diagnosis. The bowel discharges at this time, though markedly fœculent, still contained masses of blood-streaked mucus. Examination of this showed the presence of the characteristic cellular exudate of bacillary dysentery. However, the picture indicated a subsidence of the toxic process. In view of this and the fact that the constitutional symptoms had abated, the physician determined not to administer serum. The patient was thereupon placed on a bland diet and colonic irrigations.

The following day (the sixth day after onset) the patient visited me again, bringing with him a specimen of his stool. This was a hard, formed, normal-looking fœcal mass, the external surface of which was invested with a glistening coat of brownish mucus. Examined under the microscope this was seen to contain numerous endothelial macrophages, polymorphonuclear leucocytes, erythrocytes, plasma cells, "epithelioid" cells, as well as considerable fœcal débris and bacteria. There also was a rich infestation with *Blastocystis hominis*. Most of the cells were in fairly good condition, signifying a cessation of the toxic process. A field from the stained exudate of this day is shown as Plate 3, fig. 1. The features enumerated above will be recognized in the figure as well as the fairly intact condition of cells and their nuclei.

The patient at this time complained of dull abdominal pain. His bowel movements averaged about two per diem and were formed to a degree bordering on constipation. Mucus always was present on the external surface of the fœcal masses when microscopic examination of his stool was made at intervals of four or five days during the following three weeks. There was a progressive decline in the number of polymorphonuclear leucocytes and endothelial cells until, on the twenty-sixth day, the latter had entirely disappeared, and only an occasional leucocyte could be found. The bacillary exudate

had now become replaced by one that consisted almost entirely of columnar epithelial cells.

At this time (the twenty-sixth day) the patient was about his business, but distinctly below par. He had a mild secondary anæmia and complained of dull uneasy sensations in the abdomen.

Inspection of Plate 3, fig. 2, will show the state of affairs on this day. It will be seen that the pathology of the colon at this stage had been reduced to a desquamative process involving the columnar epithelial cells of the mucosa, and unaccompanied by any marked suppuration. The process apparently was not limited to the cells on the surface of the mucosa, but would seem to have extended at least a short distance up into the glands of Lieberkuhn, for a number of cells were found which, though partially degenerated were, in all probability, goblet cells. On the thirty-third day the patient's stool was soft and contained considerable mucus in which, however, only a few scattering cells could be found. He was allowed gradually to return to full diet and was given instructions to report to the microscopist at intervals of about a week.

CASE R

American woman, aged 35 years. While on a visit in Stotsenburg, Pampanga, she contracted a mild attack of bacillary dysentery from the acute manifestations of which she recovered under treatment with salines, in a few days. She then returned to Manila and about a week later came down with a typhoidlike fever. This ran a mild course for about three weeks and she convalesced rapidly. Several attempts were made during the course of her illness and afterwards to secure a Widal reaction but it always was negative. On leaving the hospital the patient resumed her normal diet and social life, but within a few weeks began to experience vague abdominal discomfort. She lost weight and developed a low-grade secondary anæmia. There was no diarrhœa, her stools being almost constantly formed.

Eventually, the case was referred to me for study. The first faecal sample submitted was formed and normal in appearance except for a streak of thick, tenacious, brown mucus adherent to the surface. The interior of the faecal mass contained no more mucus than one ordinarily encounters in a normal stool. The outlying mucus was rich in cells, however, most of them being epithelial cells of the columnar type cast

off from the mucous membrane. These cells had undergone degeneration and maceration to the extent that they were considerably distorted. Only occasional leucocytes were to be seen, any accompanying suppurative process that may have been present being apparently very mild. These features of the exudate will be seen on inspection of Plate 4, fig. 1, which is of a field in which the cellular débris was diffuse. Other fields showed blocks of columnar cells similar to those shown in Plate 3, fig. 2. While retaining much of their natural form, the nuclei of these cells had undergone pyknotic degeneration and the cytoplasm was homogeneous and formless.

A diagnosis of post-dysenteric ulceration of the bowel was made. The patient was placed on bland diet, colonic irrigations, and mild laxatives. Her general condition improved, as did her blood picture. Resumption of normal diet, however, brought about a return of the general symptoms and a reappearance of the mucus and cells. In fact, at no time during the period in which I had the case under observation was her stool entirely free from mucus and cellular débris. She relapsed in this way several times, although at no time did she develop markedly acute symptoms. Eventually, she was sent back to the United States and I lost further track of the case. I found neither protozoa nor helminths in this patient's fæces.

CASE T

An American boy, 5 years old. He and his father and mother all developed bacillary dysentery on the same day. All three cases ran a mild course. I did not have the opportunity to follow the cases of the father and mother, but their clinical recovery, at least, seems to have been complete. The exudate passed by the child at onset was typically bacillary, and he was running a temperature of 101° to 102° F. Serum was refused by all three and treatment consisted of the administration of saline laxatives and regulation of the diet. On the third day, the father brought me a fæcal specimen from the child and presented it to me with the remark that it was scarcely worth examining, because the child was perfectly well and playing about the house. The specimen was a large, yellow, formed mass of fæces, superficially normal in appearance. Closer inspection, however, showed it to be covered with the familiar coating of glistening mucus, which was streaked with blood.

The cellular content of this mucus is well shown in Plate 4, fig. 2. The exudate will be seen to be composed of erythrocytes, polymorphonuclear leucocytes, and degenerated columnar epithelial cells, together with cellular bodies of uncertain origin. It will be seen to present points of similarity to the exudates shown in Plate 4, fig. 1, and Plate 3, fig. 2. In other words, although the exudate had lost most of its bacillary characters, a suppurative process was still in progress accompanied by desquamation of the cells of the mucosa.

I explained to the father that his child was far from well and, on the contrary, needed careful dieting and treatment. Apparently this advice went unheeded and I did not hear of the case for several weeks, when I learned that the child had been losing weight and had been taken to the hills. A few weeks later the child developed severe intestinal symptoms and was brought back to Manila. Examination of the stool at this time gave evidence of a disturbance extending throughout the entire intestinal tract. The specimen sent to me contained lumps of undigested meat and other food and masses of mucus. The latter contained considerable epithelium and scattering pus cells. Another attempt was made to impress upon the parents the importance of caring for this condition, but the family physician later reported to me that he was unable to enforce his dietary and other regulations. I saw nothing further of the case.

CASE P

An Englishman, 33 years of age. While on a business trip to Iloilo he contracted bacillary dysentery which ran a sharp course for a day or two. In the interim he was treated with emetine and bismuth, so that he was able to board a steamer and return to Manila. He continued the treatment en route. His physician, doubting the original diagnosis of amœbic dysentery, referred the patient to me for a check on it. This was on the sixth day after the onset of symptoms. At this time the patient's stool was mucofœculent. It contained a rich leucocytic exudate, numerous endothelial macrophages, and blood. No amœbæ were found.

As the constitutional symptoms had abated by this time, the patient was placed on saline laxatives and restricted diet. Within a few days his stools had become formed to hardness, but the fœcal masses were smeared with mucus rich in cellular exudate. Plate 5, fig. 1, shows this exudate on the fifteenth day.

As will be seen from inspection of the figure, the essential features of the bacillary exudate are still present, though the process was obviously one of low toxicity. In all probability the persistence of this exudate was due rather to an extension of the infection to new areas on the bowel than to a persistence of the original involvement. It formed a striking illustration of the fact that the bowel may be undergoing considerable damage at a time when the clinical symptoms and gross appearance of the stool give no inkling of the truth. However, as the patient was able to pursue his customary occupation, no specific treatment was given, but he was kept on soft diet, mild colonic irrigations, and mild laxatives, notwithstanding his appetite was fair.

On the twenty-second day, his stool was formed but not hard. It still contained considerable cell-laden mucus, however. Plate 5, fig. 2, represents a photograph from a preparation made on that day. It will be seen that the regressive process was well on its way. There is total absence of macrophage and "epithelioid" cells. This is in sharp contrast to the previous picture in which cells of several types showing varying degrees of degeneration are scattered throughout the field. Annular degeneration of leucocyte nuclei still is present, to be sure, but that is a phenomenon that is seen in inflammatory processes other than bacillary dysentery.

The dietary régime and colonic irrigations were continued and on the twenty-ninth day the stool, though containing some mucus, yielded only scattering cells so degenerated that they could not be classified. The patient had gained weight and his general condition of health seemed excellent. He was told to resume his normal diet cautiously and report to the microscopist at intervals of about ten days. He has since shown no tendency to relapse, either clinical or microscopic.

When exudates of the type described in connection with these four cases are rich, they may present a superficial resemblance to the exudate of acute bacillary dysentery, for which they may be mistaken by the novice or the careless worker. However, a little careful study, checked by preparations stained with hæmatoxylin and eosin, will obviate mistakes. The type of predominating cell, of course, rules out any acute suppurative or toxic process. Moreover, the type of cellular degeneration will be seen to present certain differences.

In a general way, these four cases all ran a similar course, but the first three will be seen to have differed from the last

in that they developed a distinct desquamative stage unaccompanied by any marked suppuration, whereas the last would seem simply to have passed through the normal stages of cellular involution consequent upon an access of bacillary dysentery of moderate severity, with the shedding of a considerable number of epithelial cells. This desquamative process I already have described.^(4,5) It is one I have seen many times in post-dysenteric cases, particularly those of bacillary origin. It is what might be styled a distinct entity, and is one that should not be confounded with what sometimes is seen in the late stages of the extremely fulminating types of dysentery. In the latter, the clinical condition of the patient rapidly grows worse until it is grave in the extreme. The bowel discharges become liquid, the serous fluid being deeply blood-stained and heavily laden with epithelium. As the destruction of the mucous membrane rapidly progresses, the mucus disappears from the stools and its place is taken by necrotic sloughs or even casts.

The process I am here describing is accompanied by no such phenomena. The patient is not acutely ill, and the stools usually are fæculent and formed. No tissue sloughs are formed, but occasionally masses of cell-laden mucus are cast off that superficially resemble sloughs. Blood is conspicuous by its absence. The striking feature of the exudate lies in the type of degeneration shown by the cells. This would appear to consist, as I have said, largely in maceration and plasmolysis of the cells as a result of the unfavorable physical environment in which they find themselves on being cast off from the mucosa. In as much as the fæcal mass usually is formed and moves rather slowly, this influence works on the cells for a matter of hours. In consequence, the protoplasm appears to undergo a process of partial liquefaction with the result that the cytoplasm loses its finer structure and the nucleus becomes reduced to a homogeneous blob of what has been chromatin. This tends to be drawn out in making a smear preparation and it appears as coarse shreds and fibers when stained with hæmatoxylin. Polymorphonuclear leucocytes, when present, remain fairly intact, but their nuclei are homogeneous or pyknotic to a degree greater than that seen in healthy leucocytes, and never exhibit the annular degeneration characteristic of truly suppurative processes. Erythrocytes are conspicuous by their absence.

In short, the cytology of this exudate bears not the slightest resemblance to that of bacillary dysentery, and it needs only

cursory analysis to make that plain. Moreover, it is not necessarily a transient phenomenon, for I have known the condition to persist more or less continuously for months at a time.

I can offer no explanation of this strange appearance, especially as it seems not to be a feature of an inflammatory process, in the strict sense. How much of it is mechanical and the result of erosive action of formed fæces on a mucus membrane rendered unstable as to its attachments by a preëxisting inflammatory process, I cannot say. It may be consequent upon œdema of the gut wall. When this desquamative process becomes finally established, the exudate consists of little else than mucus and columnar epithelial cells.

At all events, it would seem quite clear that considerable areas of the gut become denuded of their protective epithelium. Unless this is pushed off in some reparative process, or immediately replaced by other cells, it is difficult to see why more or less extensive areas of infection do not develop. That such infection does occasionally occur I shall endeavor to show by the next case, which is typical of several of its kind that I have seen during the past few years.

CASE L

American male, aged 43 years. It is a matter of regret to me that I have not a complete history of this case and I can only report on it as it came to me. The observations made, however, tell a story of their own so I have no hesitation in citing it here. This man had resided in the Philippine Islands for many years and was engaged in the lumber business in Occidental Negros. About six months prior to the time I saw him, he suffered a severe attack of dysentery. From his description I have no doubt that this was of the bacillary type. He received such treatment as was available at the lumber camp but, of course, there was no serum on hand. The dysentery ran a very acute course, and his convalescence was prolonged. Eventually, he was able to resume work, but he steadily lost weight and the general decline in his health was marked. Dull pain in the abdomen persisted, and his stools remained mucoid and soft in consistence.

As he failed to improve he came to Manila. By this time he was unable to go about, so his physician placed him in the hospital. His condition there became very serious and a fatal outcome seemed imminent. He had a pronounced secondary anæmia, a leucocytosis of about 14,000, and a differential blood count showed an eosinophilia of 18 per cent.

The case was then referred to me for study. He had been on liquid diet, and his stool consisted almost entirely of a thick creamy mass of pus. I frequently made stained preparations of this, and never found endothelial cells. Occasionally, a stray mononuclear blood cell or a plasma cell would be discovered, but the exudate, to all intents and purposes, consisted entirely of polymorphonuclear neutrophiles, the nuclei of which showed the ordinary type of annular degeneration. Each preparation made contained a few amœbæ in the precystic stage, but they were degenerated, and the man returned to his station before I could determine the species of the amœbæ. In addition to this, he had a moderately heavy infestation with hookworm. The features of this exudate are pictured in a very characteristic field as Plate 6, fig. 1. Repeated efforts were made to recover *Bacillus dysenterix* in culture, but without success.

Notwithstanding the serious condition of the patient, it was deemed wise to rid him of his hookworm infection. Accordingly, he was given 10 cubic centimeters of carbon tetrachloride, from which he experienced no serious discomfort. As a result of this he passed a large number of worms. No worm count was made, because only the first stool was saved, but this was seen to contain many hookworms.

He was then placed on a strict diet, from which all bulky or irritating food was excluded, and given mild colonic irrigations. This treatment was continued for three or four weeks, during which time the pus gradually disappeared from his stools. He then began to gain weight rapidly. At the end of a year the man had regained his normal weight and was in perfect health, he told his physician, aside from a slight degree of constipation.

On reviewing the evidence it will be seen that this case presented the following outstanding features:

1. A severe attack of dysentery, probably of bacillary origin; inadequately treated.
2. Prolonged convalescence, in consequence, succeeded by general decline in health and persistently abnormal stools. No treatment during this period.
3. The discharge of creamy, purulent matter from the intestine with accompanying leucocytosis and marked prostration.
4. The exudate consisted almost entirely of polymorphonuclear neutrophiles. Macrophages never were found. *Bacillus dysenterix* could not be recovered in culture on repeated attempts. Therefore, there was no evidence of bacillary dysentery.

5. Amœbæ were present, but only in the precystic stage. Trophozoite forms of amœbæ never were found. Therefore, the case was not one of acute intestinal amœbiasis.

There was, in consequence, no evidence that the process was dysenteric in nature.

I think there is no reasonable doubt that the purulent discharge from this man's intestine was the direct result of inadequate treatment of his dysentery and his failure to receive proper after-care. Such a case coming to the microscopist unaccompanied by a clinical history very likely would be mistaken for one of bacillary dysentery unless a careful search were made for macrophages. Such a search, of course, always should be made. The diagnosis of acute dysentery by the study of the cellular exudate is a safe and accurate procedure, but judgment never should be rendered until the microscopist has thoroughly analyzed his material. A diagnosis of bacillary dysentery made on the presence of a heavy leucocytic exudate, uncorroborated by the finding of endothelial macrophages and evidence of toxic necrosis, is entirely unwarranted and, as this case illustrates, may lead to serious mistakes. It is true that most, possibly 95 per cent, of the heavy polymorphonuclear exudates prove to be of bacillary origin, but heavy pus exudates occur with sufficient frequency in suppurative conditions in the colon as well as in balantidial dysentery to make it absolutely essential that the microscopist should assemble the complete picture, even resorting to stained preparations, before making a diagnosis of bacillary dysentery. These remarks are based on one or two unhappy mistakes I, myself, have made. Fortunately, these were unattended by serious consequences.¹

"One of the most striking illustrations of the need for caution in the interpretation of an aberrant picture that I ever have seen is afforded by the following case:

CASE M

The patient was a girl, aged 12 years, who developed bacillary dysentery during the course of an outbreak of mild degree

¹ Connal and Young, Trans. Roy. Soc. Trop. Med. & Hyg. 16 (1922) 90, in reporting a case of infection with *Isospora hominis* in a young European in Nigeria, speak of the repeated occurrence of columnar epithelial cells in the fæces of their patient. He gave a history of chronic amœbic dysentery considerably antedating the discovery of his coccidial infection. Wenyon and O'Connor, Human Intestinal Protozoa in the Near East, also mention the presence of these cells in fæces without, however, entering into a discussion as to their significance.

among the Americans and Europeans in Manila in July of this year. At onset, the child's temperature mounted rapidly to 102° F., and there were abdominal cramps of moderate severity accompanied by the passage of frequent bloody, mucoid bowel movements. The general condition of the patient remained good, however.

On a microscopic diagnosis of bacillary dysentery, the attending physician administered two doses of antidysenteric serum of 20 cubic centimeters each. As a result of this, the patient's temperature fell to normal the following day, the pain subsided, the bowel movements lessened in frequency and by the fourth day convalescence seemed to be well established. The stool on that day was soft and mucofæculent, but contained considerable pus, scattering erythrocytes, and an occasional macrophage, showing that the bacillary process had subsided almost completely and had been succeeded by the usual residual suppurative process.

Despite the fact that the clinical condition of the patient was entirely satisfactory, the attending physician ordered the administration of a colonic irrigation of physiologic salt solution and hydrogen peroxide. This caused great pain and considerable distention of the bowel which persisted through the night. The following morning the child's temperature was normal, but toward noon it gradually rose until a maximum of 101° F. was reached. A copious, watery stool was passed, which almost immediately after was followed by a blood-tinged, watery stool containing masses of cell-laden mucus.

At first glance, this exudate closely resembled that of bacillary dysentery. The cellular exudate was massive, and showed the presence of numerous erythrocytes and an occasional macrophage. The first impression was that there had been a recrudescence of the dysenteric process. The general form of the cells was different, however, and there seemed to be other differences of a somewhat intangible nature. Accordingly, a number of films were fixed and stained. As a result of this procedure it was discovered that the smaller cells that composed the bulk of the exudate were not polymorphonuclear neutrophils, but were, instead, circular to oval cells with deeply staining pyknotic nuclei. The cells were hydropic and the nuclei were excentrically placed in the majority of the cells. Here and there were encountered macrophages and, occasionally, small groups of polymorphonuclear neutrophils. These elements are shown in the figures composing Plate 8.

I am not prepared at this time definitely to classify these mononuclear cells. I am inclined to regard them provisionally as plasma or irritation cells; but one of my colleagues, a pathologist of wide experience, who kindly studied the exudate for me, hazarded the opinion that they might be hydropic epithelial cells. While not entirely dissenting from this view, I beg to call attention to Plate 8, figs. 2 and 3. Figure 2 shows, at A, one of these cells which had phagocytosed an erythrocyte—a most improbable feat for an epithelial cell; fig. 3 shows two cells, at E, which I think there is little doubt are degenerated columnar epithelial cells. Their nuclei will be seen to be approximately in their normal position, and they bear no real resemblance to the cells under discussion. Figure 1 shows a large field of this exudate; it may be compared with Plate 7, fig. 2.

At all events, I interpreted this curious picture mainly as the expression of a rather energetic reaction of the intestinal mucosa to the strong hydrogen peroxide solution. The macrophages may have represented a mild extension of the bacillary dysentery to a new area of the bowel. The leucocytes probably were associated with the latter, and also with the residual secondary infection of the bacillary ulcers formed on the initial attack.

These features of the exudate were discussed with the physician who had been called on the case after the administration of the hydrogen peroxide irrigation, and it was agreed that the bulky exudate probably was, in greater part, the manifestation of a profound reaction on the part of the intestine to the irritation produced by the hydrogen peroxide. We were inclined to regard the presence of macrophages as possibly due to an extension of the dysenteric process to a hitherto uninvolved portion of the gut. In view of the facts that the elevation of temperature was not extreme, and that the general condition of the patient was good, it was decided to defer the further administration of serum for a few hours. Shortly after this the patient's temperature fell, and it became normal early the next day. From that time on, convalescence was uninterrupted.

Aside from the clinical lesson, upon which I need not dilate, there is a valuable lesson to the microscopist afforded by this occurrence. It consists in an exudate which on initial inspection appeared to bear the characters of a typical bacillary exudate, but which on brief study of hastily stained preparations proved to be something entirely different. These differences, it

has been seen, influenced the clinical management of the case at that period.

Moreover, this picture should be carried in mind by the microscopist. It is the practice of some physicians to administer colonic irrigations, sometimes with more or less irritant solutions, in conjunction with other antidyenteric treatment. Under such circumstances, the persistence of a massive cellular exudate, at a time when the patient is progressing well clinically, should arouse curiosity as to its nature. In this event stained preparations should be studied before it is assumed that the patient is suffering from a serious extension of the bacillary process.

It is with some hesitation that I take up the final topic of this paper—the presence of eosinophiles and plasma cells in the watery discharges accompanying allergic reactions in the gastrointestinal tract. My object simply is to record some rather incomplete observations I have made in a few cases in order that I may give the cue to other workers whose opportunities may lead them to the study of a greater number of cases of intestinal allergy under more favorable conditions for study than I have enjoyed. I believe this is important for the following reasons:

1. A heavy eosinophilic exudate may simulate the leucocytic exudate of bacillary dysentery in the fresh preparation, especially as the glistening eosinophile granules bear a very striking resemblance to the fatty and other cell inclusions in bacillary dysentery.

2. The value the cytology of this eosinophilic exudate may hold in establishing a differential diagnosis between intestinal allergy and bacillary dysentery or cholera.

3. The light that the presence of large numbers of eosinophiles in intestinal allergy may throw on the entire question of the significance of eosinophilia in general. To me this is especially suggestive, in view of the current beliefs concerning eosinophilia in asthma, certain dermatoses, parenteral injections of serum, and other conditions in which the introduction of foreign proteins seems to play a part. My observations on eosinophilia in various parasitic invasions in natives of the Philippine Islands are leading me to suspect that it is an expression more of the reaction on the part of the host organism to a foreign and unwelcome protein than it is to a specific toxin, as such, elaborated by the parasite.

For the purpose of outlining the subject, so far as it pertains to intestinal allergy, I shall briefly discuss three cases.

CASE BL

American woman, aged 46 years. She had served for many years as a missionary in China and the Philippine Islands. During her sojourn in the East she had had both malaria and dysentery. Whether her dysentery was of the amœbic or the bacillary type I cannot say. Her stools never were entirely normal and, though I occasionally encountered Charcot-Leyden crystals, I never, in the two years in which I intermittently studied her case, discovered parasites of any species. Periodically, however, especially when her stools became constipated or she suffered from some gastrointestinal upset, large numbers of columnar epithelial cells and considerable mucus appeared in her stools. She also was extremely sensitive to fish, and was made violently ill by it several times during the period of observation. This brought her frequently into the hospital where she sometimes had to remain for several days. At other times she suffered from vague abdominal discomfort, and was anæmic and unfit to perform her duties.

During one of these periods and at a time when her stool contained considerable mucus and epithelium, she ate a small amount of fish and a few hours later came down with abdominal cramps, purging, and vomiting, accompanied by considerable prostration. A specimen of bowel evacuation sent to me was watery and bore a close resemblance to the rice-water stool of cholera. This appearance was due to the presence of innumerable flakes of mucus containing columnar epithelial cells. The making of stained preparations was attended with considerable difficulty because of the watery nature of the stool, which not only made it difficult to fix the material on the slide, but damaged the cells considerably.

A field from a preparation of this stool is shown as Plate 6, fig. 2. The exudate will be seen to consist mainly of columnar epithelial cells showing the same type of degeneration as has been discussed above. Scattered about among these epithelial cells, however, are numerous eosinophiles. The nature of the material makes it difficult to show these clearly, so that I must ask the reader to accept my statement that they were very numerous. The attack subsided within a few hours and with it the eosinophiles disappeared from the exudate.

CASE V

Filipino male, aged 23 years, employed as an attendant in my laboratory. He was seized with cramps, vomiting, and purging about ten hours after he had eaten a heavy meal of shrimps. Though I did not know it at the time, he told me afterward that shrimps had made him sick before. The exudate in his stool was so rich in cellular content that I made a provisional diagnosis of bacillary dysentery and sent him to the hospital. There he was given a purge of sodium phosphate and 20 cubic centimeters of polyvalent antidysenteric serum. His symptoms almost immediately subsided. His stool passed early the following day, though only semifformed, contained neither mucus nor cells in recognizable amounts.

The material obtained from this case was in better condition for study than that obtained from the two other patients in this group. Inspection of Plate 7, figs. 1, 2, and 3, will show that this exudate was made up of two principal types of cells, eosinophiles and plasma cells. Cells of the latter type seem to be present in a variety of conditions involving the more superficial portions of the mucosa. In fact, they appear to be among the first to respond and the last to disappear in bacillary dysentery and allied conditions.

An interesting feature of the exudate in this case was the distinct separation between the eosinophiles (fig. 1) and the plasma cells (fig. 2). The segregation was almost complete in all parts of the films. Polymorphonuclear neutrophiles were present in very small numbers; three are shown in fig. 3. Other blood cells were present in insignificant numbers.

Inspection of the figures, particularly fig. 3, will show that the nuclei of these eosinophile cells bears not the slightest resemblance to the polymorphous nucleus of the eosinophiles encountered in blood smears. The nuclei are distinctly annular with a central granule like a karyosome. Usually one or, at the most, two of these are found in each cell. These are sharp and clean-cut like the "ring nuclei" in degenerated pus cells and do not look as if they could be the product of the typical washed-out nucleus of the eosinophile cell of the blood stream. However, it will be seen that the nuclei of the polymorphonuclear neutrophiles in this case have undergone annular degeneration.

CASE PN

American male, 38 years old. The clinical symptoms and the gross appearance of the stool were almost identical with

those seen in the two other cases. The exciting agent here was clams, which had produced other similar attacks in this patient in the past. He was very violently ill for several hours, but recovered promptly and completely under purgation and stimulation. Unfortunately, I did not receive one of the earlier stools for examination, the specimen provided me having been passed some three hours after the onset. It presented the same technical difficulties as the others. However, two successful preparations were made which showed scattered clumps of eosinophiles. There also were a few isolated plasma cells and an occasional leucocyte. One of the clumps of eosinophiles is shown (Plate 7, fig. 4). The cells are badly macerated and their nuclei are indistinct, but there is no doubt of their identity.

Such are the data I have to offer on this phase of the microcopy of intestinal exudates. I realize it is very indefinite, but I submit that the lead is worth following up by those to whom the opportunity comes.

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ILLUSTRATIONS

[All figures are photomicrographs of fields in the author's preparations from the exudates of the cases described in the text. The subjects were posed by the author, and the photographs, with the exception of those forming Plate 8, were taken by Maj. George R. Callender, M.C., U.S.A., of the United States Army Medical Department Research Board, stationed in Manila. All preparations were wet fixed in Schaudinn's fluid. The preparation shown in Plate 1, fig. 8, was stained with Heidenhain's hæmatoxylin and picro-acid fuchsin; that of Plate 6, fig. 1, with Heidenhain's hæmatoxylin. All the others were stained with Delafield's hæmatoxylin and eosin.]

PLATE 1

- FIG. 1. Exudate of bacillary dysentery in which the macrophage cells are uniformly distributed. This is a relatively thin portion of the smear, but the high proportion of polymorphonuclear leucocytes is apparent. Note evidences of toxic degeneration in all types of cells, especially the macrophage (M).
2. Exudate of bacillary dysentery in which the macrophage cells are relatively more abundant and occur in clumps. The dark bodies lying in clear, vacuole-like spaces are erythrocytes that have been phagocytosed by the macrophages.
 3. High-power view of macrophage cells and polymorphonuclear leucocytes. Note the complete dissolution of the nuclei of the macrophage cells (compare with Plate 3, fig. 3) and the annular degeneration (ringing) of the nuclei of the polymorphonuclear leucocytes. The cell in the upper right corner (L) probably is a large mononuclear leucocyte from the blood stream.

PLATE 2

- FIG. 1. Exudate of amœbic dysentery uncomplicated by secondary bacterial infection of amœbic ulcers. Note the trophozoite of *Entamœba histolytica* (A), containing ingested erythrocytes and the Charcot-Leyden crystal (C). The dark bodies occurring singly and in clumps are erythrocytes. Other blood or tissue cells, with the exception of a degenerated leucocyte, will be seen to be absent.
2. Exudate of amœbic dysentery, complicated by marked secondary bacterial infection of amœbic ulcers. A trophozoite of *Entamœba histolytica* (A) will be seen together with numerous erythrocytes. The salient feature of the field is afforded by the numerous polymorphonuclear leucocytes. They do not, however, constitute the massive content shown in Plate 1, fig. 1, and, moreover, they will be seen to be practically intact, showing evidence of neither toxic necrosis nor proteolysis.

PLATE 3

- FIG. 1. Exudate in mucofæculent stool of an untreated case of bacillary dysentery, the sixth day after onset. Thin smear. Note particularly that evidences of toxic necrosis are not so marked as shown by the cells in Plate 1, fig. 1. Macrophage and "epithelioid" cell nuclei are almost intact.
2. Exudate in mucofæculent stool of same case as above on the twenty-sixth day after onset. Note that the former purulent exudate has been entirely replaced by one containing only desquamated columnar epithelial cells with an occasional leucocyte or plasma cell. The epithelial cells will be seen to have been cast off singly and in small sheets. At least one of these (G) probably is a goblet cell.
 3. High-power view of a macrophage on the same preparation shown in fig. 1. Compare with Plate 1, fig. 3. Note that, while there is a rarefied area in the cell, the nucleus, though clearly involved, has not lost its characteristic form. This is indicative of the decline in toxicity of the process even on the sixth day. The body at the lower end of the macrophage cell is a mononucleated plasma cell that overlies the extremity of the other cell.

PLATE 4

- FIG. 1. Exudate in post-dysenteric ulceration of the colon. Numbers of macerated columnar epithelial cells will be seen as well as one or two bodies that may be the remains of leucocytes. Note how the liquefied nuclear material has been drawn out in making the smear.
2. Exudate in the mucofæculent stool of a case of bacillary dysentery in a child on the third day after onset. The faecal portion of the stool was formed to hardness. The stool retains many bacillary characters, but the most conspicuous bodies in the field are macerated columnar epithelial cells showing that the residual purulent process is accompanied by desquamation of mucosal epithelium. The same streaking of nuclear material shown in fig. 1 also is shown here.

PLATE 5

- FIG. 1. Persisting bacillary process in an ambulant case, untreated by serum, on the fifteenth day after onset. All the elements of the bacillary exudate are here and probably indicate the extension of the process to a new area of the bowel. The stool was formed and faeculent to hardness.
2. Mucofæculent stool of the same case on the twenty-second day after onset. Note that the streaks of mucus are laden with polymorphonuclear leucocytes only, showing that the bacillary process had given way to a simple bacterial infection of injured areas in the mucosa. This is a very characteristic picture seen in the stools of former dysenterics.

PLATE 6

- FIG. 1. Purulent discharge from the intestine of a man who had been insufficiently treated for bacillary dysentery six months before. This discharge was pure pus in which only occasional mononuclear blood or plasma cells were seen. A precystic amoeba (A) appears near the center of the field.
2. Combined exudate of post-dysenteric colitis and intestinal allergy. All cells were badly macerated in the watery stool accompanying the allergic reaction, and very few of the eosinophile cells present are recognizable in the photograph. The cell at (E) unquestionably is an eosinophile. Other cells in the field are mainly columnar epithelial cells.

PLATE 7

- FIG. 1. Clump of eosinophile cells in the serous exudate of a case of intestinal allergy. Note their mono- to binucleated condition and compare with eosinophile cells found in the tissues.
2. Clump of plasma cells in another portion of the same preparation as shown in fig. 1.
3. Clump of eosinophile and polymorphonuclear neutrophile cells in same preparation as figs. 1 and 2. Compare the nuclei of the eosinophiles with those of the neutrophiles.
4. Group of plasmolyzed and macerated eosinophiles from the watery stool of a man suffering from intestinal allergy following a meal of stewed clams.

PLATE 8

[Photographed by E. Cortes, Bureau of Science.]

- FIG. 1. Typical field in exudate passed after administration of a colonic irrigation containing hydrogen peroxide. Note that the exudate consists almost entirely of hydropic cells with pyknotic nuclei. A macrophage is shown at M.
2. Clearer view of mononuclear cells. Note the cell at A, which has phagocytosed an erythrocyte. Compare these cells with those shown in Plate 7, fig. 2.
3. Pair of desquamated columnar epithelial cells, E, in the same exudate.

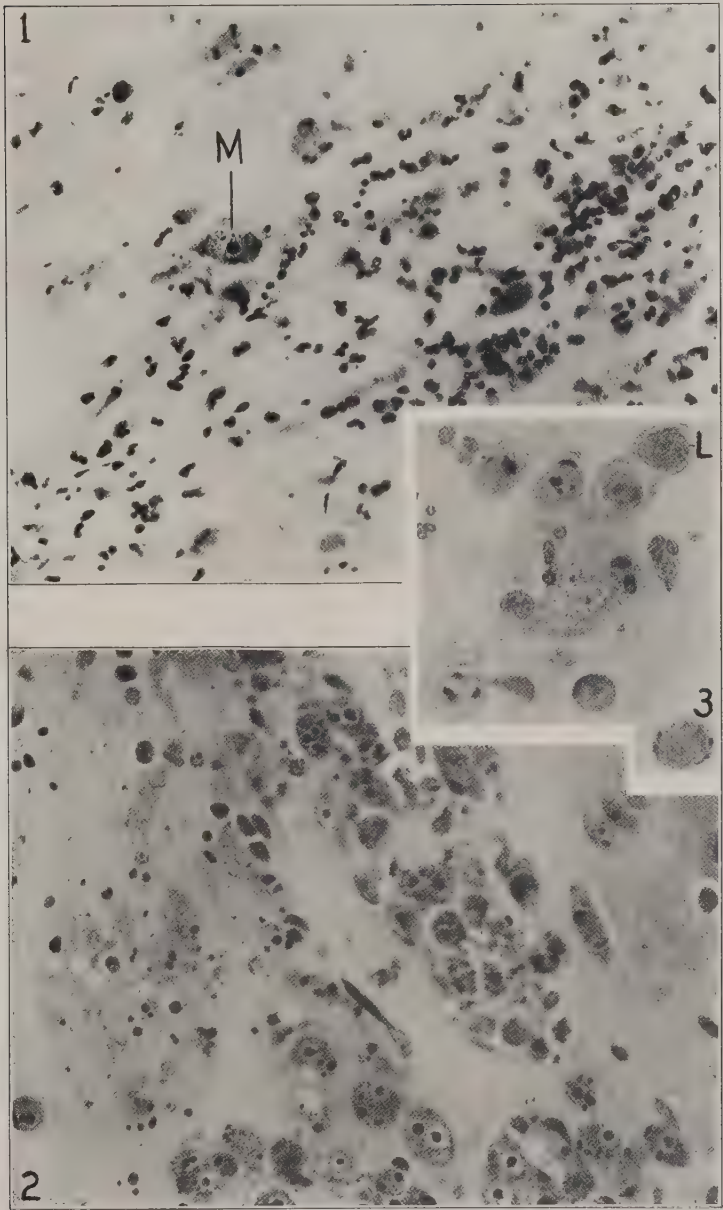


PLATE 1. TYPES OF BACILLARY EXUDATE.

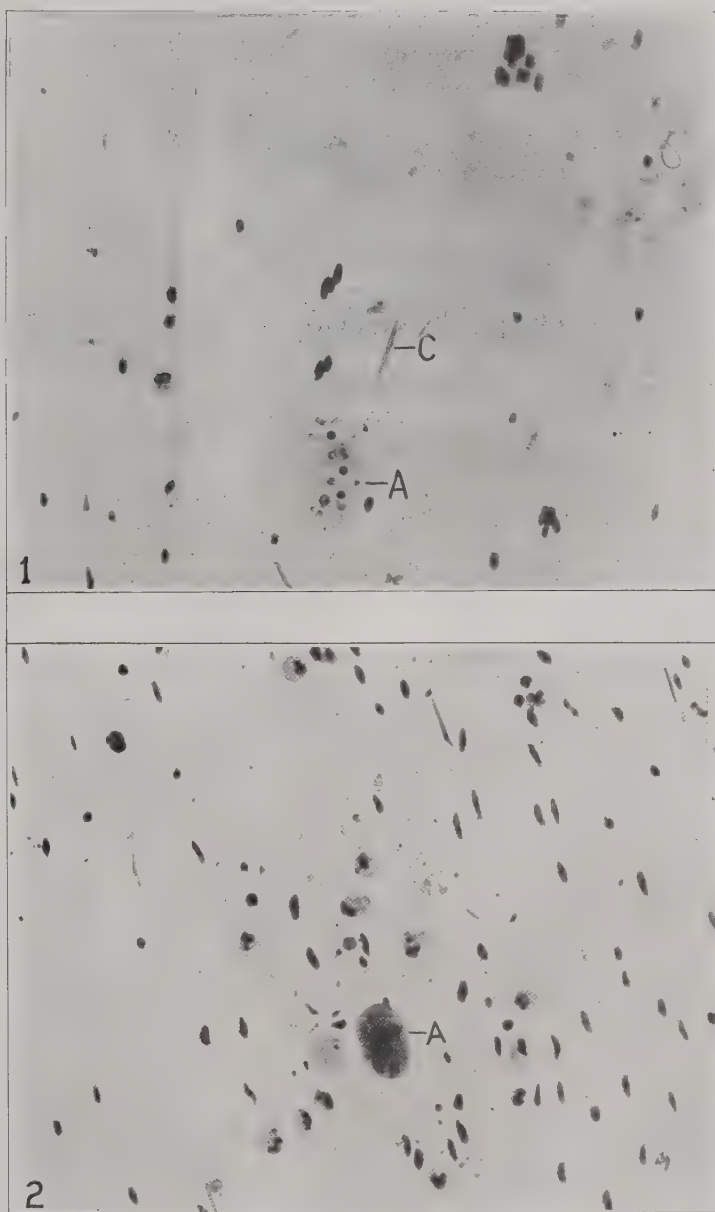


PLATE 2. TYPES OF AMOEBIC EXUDATE.

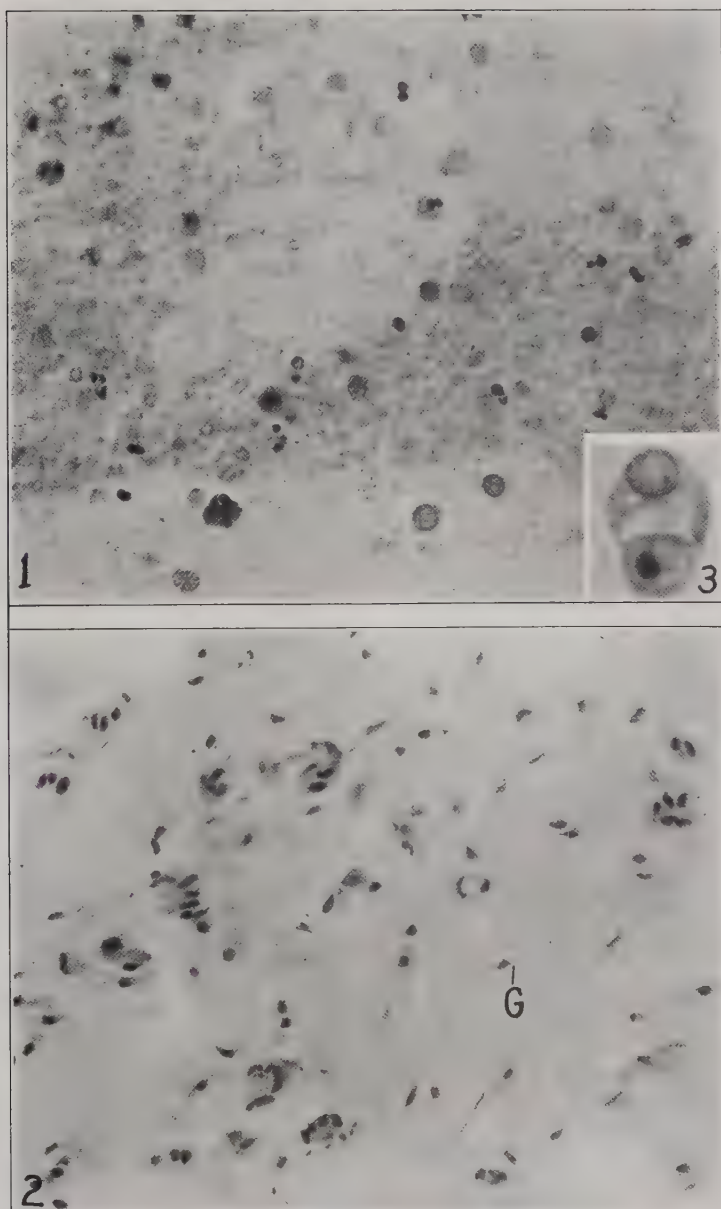


PLATE 3. EXUDATES FROM CASE B.

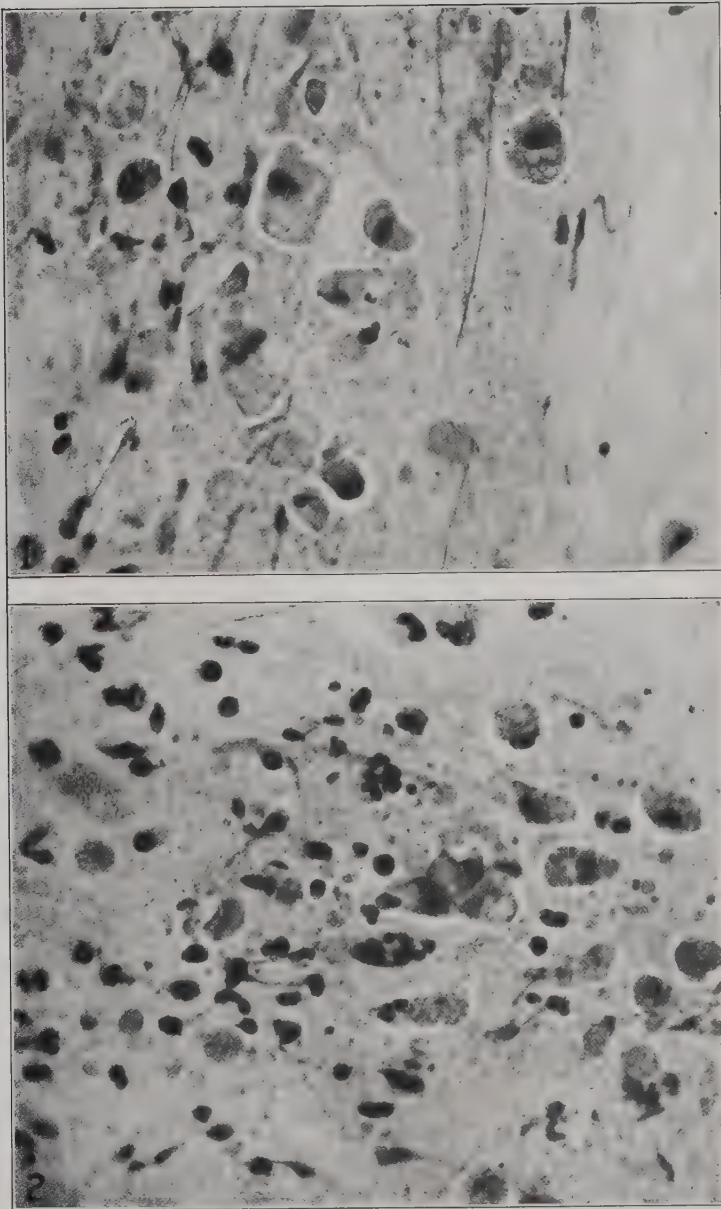


PLATE 4. EXUDATES FROM CASES R AND T.

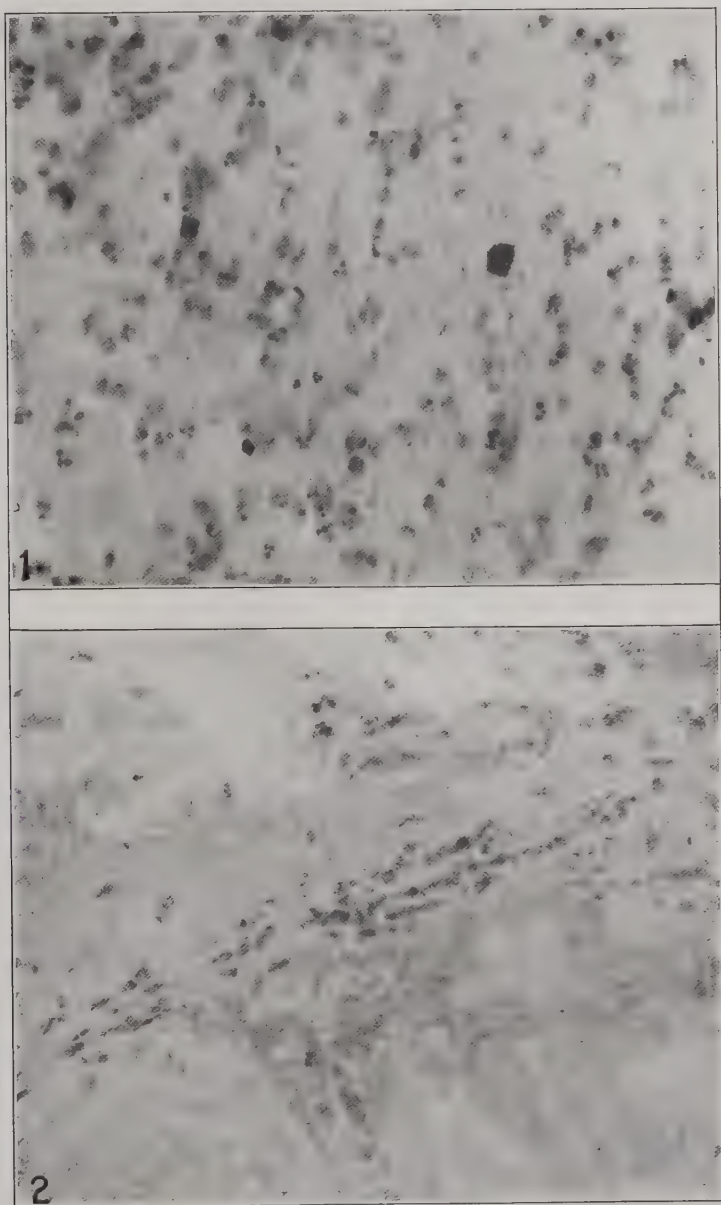


PLATE 5. EXUDATES FROM CASE P.

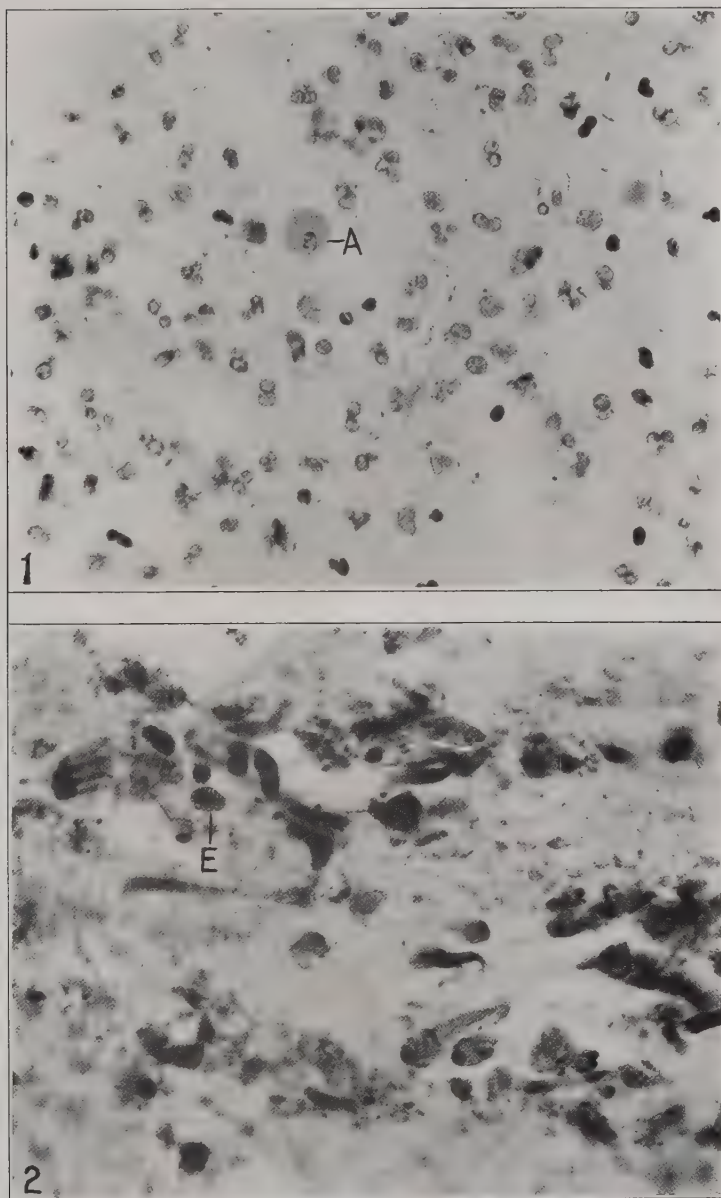


PLATE 6. EXUDATES FROM CASES L AND BL.

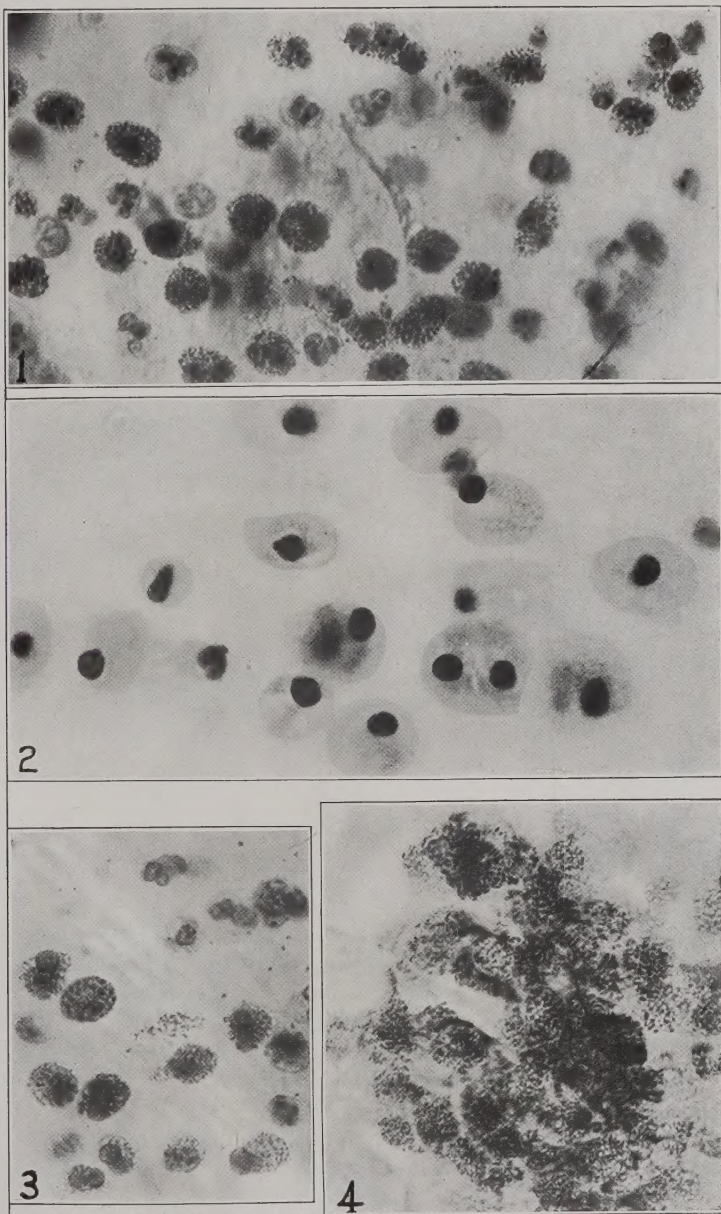


PLATE 7. EXUDATES FROM CASES V AND PN.

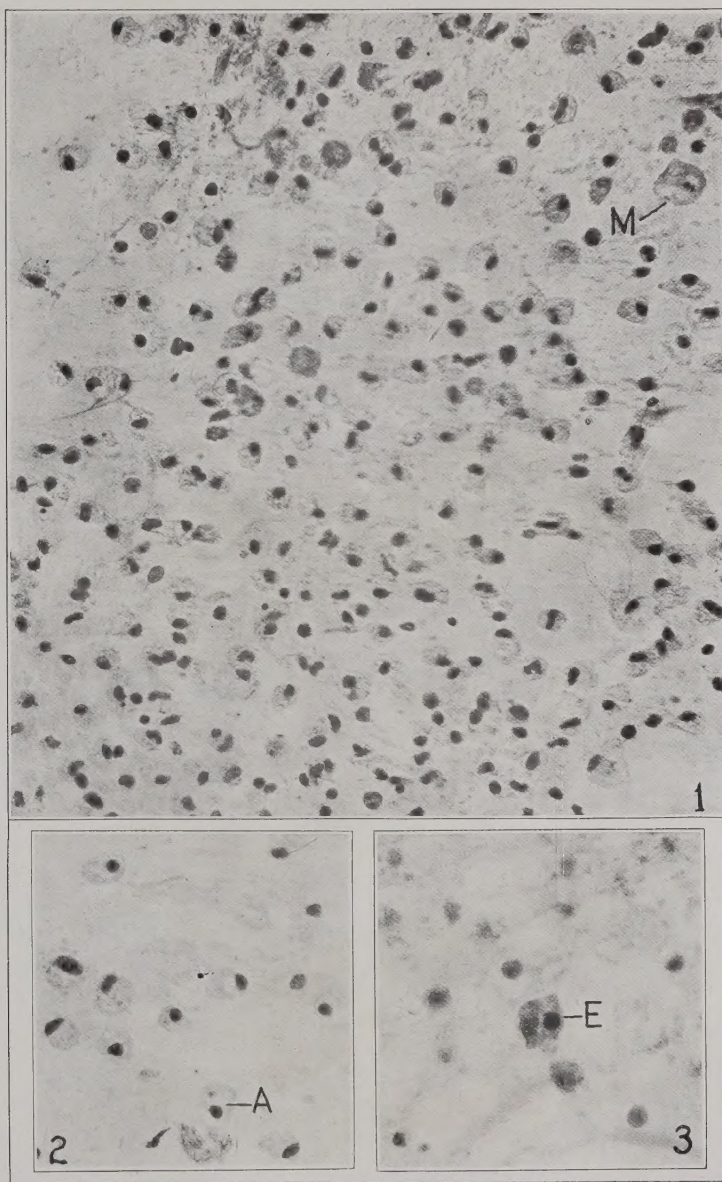


PLATE 8.

